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Department of Agriculture,
Gold Coast.

AGRICULTURE
IN
NORTH MAMPRUSI

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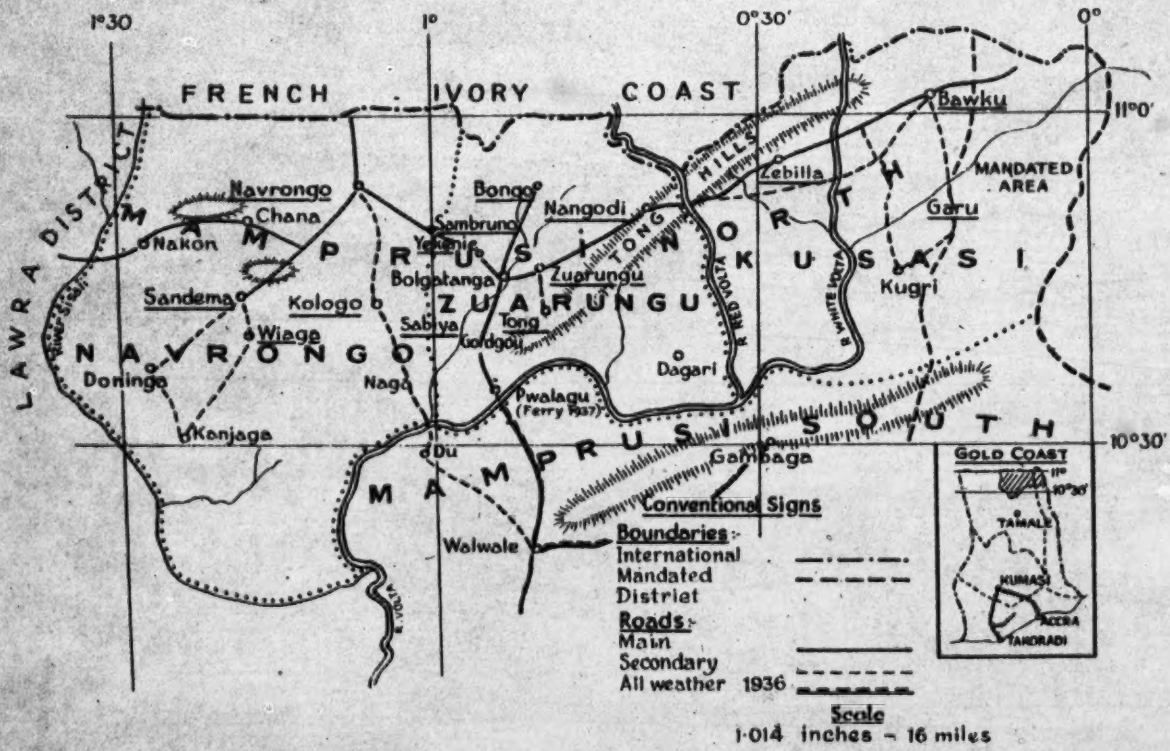
NORTH MAMPRUSI, GOLD COAST.



7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

CONTENTS

	page
000 Map of North Mamprusi	Frontispiece
Introduction	1

PART I.

STUDY OF INDIGENOUS AGRICULTURE.

Section I. *Introductory Notes on the District* ... 2

Situation—Isolation—European Contact—Climate—Vegetation—Topography and Soil—Soil Erosion—Primitive People—Absence of Villages—Fixed Cultivation—Land Tenure—Population—Political Organization—Slave Raids—Customary Agriculture—Diet—Food Shortage—Famine Foods—Economic Awakening.

Section II. *Agricultural Survey* 12

Nature of the Problem.

Survey Methods 12

Information Required—Approach to Problem—Selection of Centres—Selection of Compounds—Details Collected—Measuring Farms—Measuring Crop Mixtures—Computation of Areas—Collection of Yield Data—Cropping Schedules—Methods of Recording.

Results of Survey 17

Distribution of Compounds—Types of Farms—Areas Cultivated—Man Power and Persons Supported.

Crop Husbandry 19

Crops Grown—Methods of Cropping—Compound Farms—Farms Separate—"Bush" Farms—Manuring—Implements—Preparation for Planting—Crop Varieties—Inter-Cultivation—Harvesting—Yields—Storing of Crops.

Animal Husbandry 31

Uneconomic Position of Livestock—Numbers Owned—Cattle—Tending Livestock—Fowls.

Section III. *Discussion of Findings in Particular Relation to Food Shortage* 34

Nature of Shortage—Causes of Shortage.

Suggestions for the Improvement of Local Agriculture 37

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Part II.

EXPERIMENTAL WORK.

page

000 Section I. *General Discussion of Results* 40

Rotation Experiments, Sabiya and Navrongo—Cultivation Experiments—Implements Used—Ridge Cultivation v. Flat—Manuring—Manufacture—Compost—Farmyard Manure—Human Health—Utilisation of Manure—Residual Values—Optimum Dressing—Root Crops—Yams—Sweef Potatoes—Cassava—Coleus Potatoes—Miscellaneous Trials—Groundnuts — Rice — Sesamum — Acha Grass — Pigeon Peas—Green Manure and Fodder Crops—Gum Arabic.

Section II. *Discussion of Findings in Particular Relation to "Mixed Farming"* ... 50

Intensive System Required—Non-Burning—Manufacture of Manure—Animal Cultivation—Economics of the Plough—Export Essential—Livestock Industry — Surplus Foodstuffs — Kusasi Groundnut Trade—Conclusions—School Farms—Native Administration Demonstration Farms — Training of Staff.

Summary 59

References 61

APPENDICES

Appendix I.—Mean Monthly Rainfall at Zuarungu, Navrongo, and Bawku 64

,, II.—Details of North Mamprusi Survey (8 tables) 65

,, III.—List of Crops more Commonly Grown in North Mamprusi 73

,, IV.—Mean Yields from Experiments (18 tables) 75

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

INTRODUCTION

This bulletin records the work of the Department of Agriculture in North Mamprusi during the years 1932 to 1936. It is divided into two parts: the first contains a description of the indigenous system of agriculture and the survey methods followed in studying it; and the second gives the results of preliminary trials, as an introduction to future experimental work.

North Mamprusi comprises three political sub-districts, Navrongo Area, Zuarungu Area, and Kusasi (Bawku) Area. These areas have a number of features in common, the most important from our point of view, being a dense population, and a primitive system of "fixed" agriculture. The most densely populated area is Zuarungu, where a shortage of cultivated foods is a fairly common experience. It was mainly to find the causes of this food shortage and to suggest ameliorative measures that the Department of Agriculture commenced preliminary survey work in this area in 1932. Unfortunately, owing to shortage of staff, the work had to be suspended in 1933, with a consequent loss of continuity. It was recommenced in 1934, however, and the scope was enlarged to admit of a certain amount of experimental work at Zuarungu and Navrongo, and survey work in the Navrongo Area. Some of the survey work was also repeated in Zuarungu Area to supply confirmatory information upon 1932 data, particularly yield data, since it was known that 1932 was an exceptionally favourable season. In 1935 the experimental side of the work received more attention; similarly in 1936. And in 1936 survey work was extended to Zebilla, in Kusasi Area. Zuarungu has been the headquarters throughout.

We have now obtained a fairly detailed knowledge of local agriculture and a certain amount of experimental evidence upon the best way in which it can be improved. All our experience points to some form of "mixed farming" (1) as a solution of the problem. Mr. F. A. Stockdale, C.M.G., C.B.E. (now Sir Frank Stockdale), Agricultural Adviser to the Secretary of State, visited Zuarungu and Navrongo in December, 1935, and recommended (2) the expansion of our work to enable us to investigate more

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

121 fully a system of mixed farming suitable for the peculiar conditions obtaining locally. In 1936, the writer visited Northern Nigeria to study the progress made in mixed farming there. A report upon this visit has been published as Bulletin No. 33 of the Department (3).

It is realized that Nigerian experience can serve only as a guide to us here, for whilst environmental conditions are similar, economic conditions differ considerably. The object of this bulletin is to record the results of observations, surveys, and experimental work, as an introduction to the study of mixed farming locally. The survey methods followed have been recorded in the hope that they may be of value when similar work is contemplated in other districts.

Our method of approach to the improvement of local agriculture is by surveys and observations, followed by experiment, demonstration, and extension, in that order. So far, in North Mamprusi, we have reached the stage of experiment and quiet demonstration.

Part I.—STUDY OF INDIGENOUS AGRICULTURE.

Section I.—Introductory Notes upon the District.

128 The farming methods of the primitive tribes inhabiting North Mamprusi are practically unique in the Gold Coast. Before discussing the results of surveys and experimental work it is proposed to outline in this section some of the main features of the district which have a bearing upon local agriculture and which are likely to affect its future development. It is necessary to state that most remarks are based upon experience gained in the Zuarungu and Navrongo Areas; although most of what is said will apply to Kusasi Area, it is probable that greater experience will reveal some differences.

Situation.

131 North Mamprusi is situated in the extreme North East corner of the Northern Territories of the Gold Coast; it lies roughly between 10° 30′ and 11° North latitude and 0° and 1° 30′ West longitude and covers an area of 3,559 square miles. It is bounded on the South by South Mamprusi (Gambaga District), on the West by Lawra-Tumu District, and on the North and East by French West Africa.

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Isolation.

An important economic feature of the district is its distance from the coast, 500 miles, and from rail head, 350 miles. This means expensive road transport precluding the possibility of all but local exports with the present prices ruling on the world's markets. The isolation is further emphasised by the fact that the main road to the South is not yet all-weather. Motor traffic is cut off from the end of May until the end of November, when the Volta rivers wash away the temporary dry season drifts.

European Contact.

Contact with Europeans has taken place only comparatively recently, *i.e.*, within about the last forty years, and for some time, soldiers, police, and political officers were the only "white men" known to the people; these were followed by medical and veterinary officers. It was not until 1930 that an agricultural officer visited the district in the growing season, and then only temporarily upon locust control duty. Observations made during this visit are recorded in the Department's Year Book for 1930 (4). In 1932 practically new ground had to be broken, and a natural suspicion, increased by not altogether unfounded rumours of direct taxation, had to be overcome before the people's confidence was obtained. The importance of this confidence for the success of our work requires no stressing.

Climate.

The main climatic feature of the district is a well defined rainy season, lasting from the beginning of April until the middle of November, alternating with an intensely dry season. The mean annual rainfall at Zuarungu is 43.92", at Navrongo 47.83", and at Bawku 41.20". Monthly means are given in Appendix I. The whole of North Mamprusi is included in the Sudanese Climatic Zone (5). Rainbearing winds come from the South East, but tornadoes from the East and North East mark the beginning and the end of the rainy season; then precipitations are very localised. From November until February or March the "harmattan" (5) wind blows with varying severity.

Vegetation—Trees.

The natural vegetation of North Mamprusi is "tree savannah" (6) with fringing forest along the banks of the larger rivers. In the populated parts of the district only trees of economic value,

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

137 either as food or medicine, have been allowed to remain. The most important of these are :—

Adansonia digitata	Acacia albida
Butyrospermum parkii	Acacia sieberriana
Parkia filicoidea	Acacia arabica
Diospyros mespiliformis	Cieba pentandra
Sterculia tomentosa	Bombax buonopozense
Ficus gnaphalocarpa	Lannea acida
Tamarindus indica	Sclerocarya birrea
Celtis integrifolia	Vitex cienkowskii

Other trees of less economic value, which have been removed to make way for farming, or to provide firewood and building timbers, can be seen well represented in "ju-ju groves", "tengani" (Nankani), and on the margins of cultivation. The most important of these are :

Combretum spp.	Acacia seyal
Terminalia spp.	Acacia senegal
Anogeissus leiocarpus	Sarcocephalus russegeri
Bauhinia spp.	

Grasses.

All land which is not under cultivation carries a covering of grasses which is usually burnt-over annually, in the dry season. The composition of grass land varies according to soil, situation, and conditions of burning and grazing. Large areas of exposed land carry only a thin cover of Heteropogon contortus. On better soils Pennisetum polystachyon, "chima" (Nankani), is found on roadsides and between farms; it is valued highly as a fodder grass. Other grasses commonly occurring on waste places in cultivated areas are: Dactyloctenium aegyptium, Chloris spp., Aristida ascensionis, and Eragrostis spp. In "bush areas" Adropogon gayanus and Cymbopogon proximus are common.

Topography.

133 241 North and South Mamprusi are separated by a steep escarpment. This is an important dividing line for it marks the change from the standstone and shale rock formations in the South, to granite, quartz, and greenstone formations in the North; it is also roughly the Northern limit of yam cultivation, associated with methods of "shifting" cultivation; and the Southern limit of early

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

millet and "fixed" cultivation. The Red and White Volta Rivers rise in French Territory and flow south through North Mamprusi until they reach the foot of the scarp; here they join, and flow westward. With their tributaries the Voltas drain the whole district; they are fed mainly by surface water and from being practically dry in the dry season, they become deep, swift-moving rivers in the rains, flooding their banks and doing considerable damage to road communications. 133 241

The surface of the country is gently undulating and outcrops of granitic rocks are common. Small stony hills occur sporadically and a definite range, the Tong Hills, runs north-east through the district from Shia in Zuarungu Area, almost to Bawku in Kusasi Area. The average height of the district is between 600′ and 700′ above sea level.

Soil.

The soils of North Mamprusi are mainly derived from granodiorite. They are greyish-brown in colour and contain a high proportion of sand and gravel which makes them course in texture. Ridges of quartz occur in some places and in their vicinity the soil is very stony. In valley lands the soil is heavier, due to an accumulation of finer particles washed down from the surrounding slopes; this soil becomes very wet in the rainy season and is seldom cultivated, although it is capable of growing excellent crops of rice. Odd patches of laterite stone are found but they are not common. Parts of the Tong Hills are composed of greenstone, a rock which weathers to a rich red colour and gives rise to a fertile but exceedingly stony soil. In cultivating, the people shift the stones into contoured heaps against which the soil packs forming terraces; examples of these can be seen around Dutsi, Zanlerigu, and Nangodi. In the middle of the rainy season—July, August, and September—the water-table rises rapidly and large portions of the district become water-logged. 134

Soil Erosion.

Close arable farming with no enclosure of fields, together with the undulating surface of the country, the open nature of the soil, and the practice of burning almost every particle of vegetal ground cover during the dry season, result in very serious sheet erosion of the soil, particularly at the beginning of the rains; streams and rivers are darkly coloured by the matter carried away in suspension. The resulting loss of fertility is considerable and the stony nature of the soil is accentuated, making cultivation more

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

134 difficult. In areas where the flow of storm water is particularly swift, the top soil has been completely scoured away, leaving bare expanses of sub-soil. Where this has occurred close to roads, the rapid run-off results in considerable damage. After a very heavy rain sections of the road may be washed completely away. (An example of this occurred in August, 1936, on the road between Bolgatanga and Zuarungu.)

Primitive Nature of the People.

105 The people of North Mamprusi are divided into a number of tribes; they differ in their customs and speak different dialects of Mole, but their methods of living and farming are the same. They are all primitive pagans, with simple requirements. Little or no dress is worn other than a goatskin by men, and leaves or string by the women. There is no indigenous cotton industry, and cotton goods, which are increasingly worn to-day, especially around market centres, are all imported or manufactured by strangers, generally Moshis, in the Zongos.

Absence of Villages.

361 An important feature of the district is that the people live in scattered compounds, unlike the Dagombas and South Mamprusis who live in villages and hamlets. The distance between compounds varies considerably; at one time it was probably about the length of a good arrow shot, but closer building around centres of importance, as near markets and lorry termini, is resulting in the formation of towns. This can be seen at places like Bolgatanga, and near Government stations. Each compound resembles a miniature fort and in the past there is little doubt that it served as such: it is roughly elliptical in shape and consists of a number of round mud houses opening inwards; and the whole is enclosed by a high mud wall. Roofs are made either flat, of beaten mud, or conical, and thatched. A single narrow doorway, which can be heavily barricaded, gives entrance to the compound: the space inside is divided into compartments by low walls. Livestock are kept in an open compartment near the entrance. The land lying between compounds is farmed intensively and manuring forms a definite part of the farming system.

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Fixed Cultivation.

[161] The high density of population necessitates a system of "fixed" cultivation. It is difficult to say whether the need for 241 "fixed" cultivation resulted in the people living on their land in

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

scattered compounds, or whether closer building between compounds, on land previously available for farming, enforced the system because of the increasing distance to bush land. The result is the same, however, from our point of view. Farmers living on the edge of the densely populated areas frequently have bush farms, which are farmed by shifting methods of cultivation, as well as compound farms which are farmed continuously. 241

Land Tenure.

The customs associated with the acquisition and retention of land are intimately bound up with the religion of the people. Land is recognized as having a "spirit" which requires placating to deliver of its goodness. This is done through the "tindana" (Nankani), who is the intermediary between the "spirit of the land" and the people. It is frequently heard that "Chiefs command people, not land", and a Chief approaches the land through the "tindana". Every area has a tindana; if an area develops to an unmanageable size, a new "tindana" may be appointed by the tindana who exercised authority there before it developed. The area administered by a Chief, however, is fixed; so that Chiefs' and tindanas' boundaries do not necessarily coincide. 793 622 425

To acquire a new area of land, *i.e.*, land not known to be claimed by anyone, a prospective occupant will generally first approach the Chief of the district and state his requirements. If the Chief is satisfied as to the probity of the applicant he will refer him to the tindana, who has the final say in the matter. An application is seldom, if ever, refused. A suitable offering is made through the tindana to propitiate the spirit of the land, and the tindana may indicate a site for the new compound, and make suggestions with regard to the crops to be planted. The question of rent does not arise since there are no "money crops" and agricultural land has no value in the economic sense; there are a number of seasonal dues, however, given voluntarily to the spirit of the land, through the tindana. [427]

In demarcating areas, such natural objects as stone outcrops, water-courses, and trees, are observed. This explains the reason for the irregular outline of most farms. Once land has been conveyed through the tindana, it is held in perpetuity by the family receiving it. Presumably, when a compound is first built in a bush area, sufficient land exists immediately around it to satisfy the requirements of the family. When the family grows up and the elder sons marry, they may choose to build compounds of their own. A new compound is made as close to the parent compound as possible, either upon a new land acquired from the tindana, or upon land 428 423

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

428 allotted by the father. On the death of the head of the family the
423 male survivors inherit the land in varying proportions as tenants in common with benefits of survivorship. The eldest son assumes the responsibilities of his father and may elect to live either in his father's compound, or to remain in his own. In either case he will receive a large share of his father's farm and retain also an interest in his own. After a number of generations the distribution and ownership of land becomes very complicated in congested areas and considerable fragmentation of holdings takes place. Land not in use may be lent to another for farming, but often with a stipulation to plant non-exhausting crops.

Distribution of Population.

162 The distribution of population is very variable both from one political area to another and within each area. If one takes the the district as a whole, 3,559 square miles, the population by the 1931 census (7) is shown to be 406,566 persons; this gives a density of population of 114 per square mile (c.f. South Mamprusi 23 per square mile, and Western Dagomba 15). It is estimated that at least one-third of the total area is uninhabited, and much of this is fertile alluvial land near to rivers, where tse-tse flies abound. In other areas ruins are found for which slave raiding, sleeping sickness, and yellow fever, are variously held responsible. Table I below gives the distribution of tribes and population.

Table 1.—Distribution of Population in North Mamprusi.

Political Area	Area, square miles	Total Population	Density of Population per sq. ml.	Tribes
Navrongo ...	1,551	120,870	78	Nankani, Kassena, and Builsa.
Zuarungu ...	781	133,981	172	Nankani, Tallensi, and Nabdam.
Kusasi and Br. Togoland ...	807 420	110,614 41,101	137 98	Kusasi, Busanga, Bemoba and strangers.
Total ...	3,559	406,566	114	—

Political Organisation.

631 History shows that North Mamprusi was continually harrassed from outside (8) until comparatively recent times. The Mamprusis in the South, who were at one time a powerful and organised tribe,

conquered many of the small tribes in North Mamprusi and superimposed their rule upon the indigenous clan system. Thus many of the Chiefs in the district to-day are of Mamprusi descent and pay tribute to the Nayiri, the paramount Mamprusi Chief at Nalerigu, near Gambaga. There is little tribal cohesion amongst the family sections, or clans, and it is upon their federation into a political unit, the Mamprusi State, that political officers have been engaged recently, following Government's policy of Indirect Rule through native Administration. The clans in Zuarungu and Kusasi now come into the Mamprusi Native Administration; those of Navrongo have formed Administrations of their own. Direct taxation was introduced in 1936 and marked an important step forward. A large proportion of the money collected is to be spent upon social services in the areas of collection, and agriculture is not being neglected.

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Recent Slave Raids.

In addition to conquest from the South, the district was continually invaded by mounted slave-raiders from the North. There is no doubt that the unsettled conditions produced by these raids have had a profound effect upon the economic and social life of the people. The importance of this from our point of view is that now, with settled conditions, the people may be expected to adjust themselves, in time, to the new order of things, and to be prepared to modify their system of farming where necessary. It is probable that these invasions, together with tse-tse fly in heavy bush, tended to concentrate the population around the rocky hills characteristic of the district, where the horsemen would be at a disadvantage. The attention of the people appears to have been concentrated more upon weapons—bows and arrows, or spears, still used to-day for ceremony and hunting—than upon agricultural implements. It is also a significant fact that the indigenous system of agriculture requires no operation to be performed on the farm during the dry season, which is the season of the year when invasion would take place. The burning of the grass in the dry season may have been done to reduce the chance of surprise attack.

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Agriculture a Custom, not a Business.

As might be expected from tribes consisting of small units having continually to defend themselves and losing many of their strongest men in fighting or taken as slaves, the people in North Mamprusi remained, economically, very primitive. Although the system of agriculture is "fixed", which is generally regarded as an advance upon "shifting cultivation", it leaves much to be desired. Farming methods have not been adjusted sufficiently quickly to

241

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

241 keep pace with the growth in intensity of conditions. Farming is regarded as a custom and not as a business, with the result that in crop production and in animal husbandry the maximum is left to Nature. It is custom based upon an unsettled past which underlies the economic system.

Diet.

262 264 The diet of the people is largely vegetarian; only after religious sacrifice, or upon a very special occasion, is the flesh of cattle, sheep, goats, donkeys or dogs, eaten, subject to certain taboos. Fowls are not eaten by women, or, in some sections, by first-born male children; they are therefore not generally found in a normal diet; guinea-fowls are eaten, however, by all who can afford them. The big meal of the day is consumed in the evening and consists of cereal flour, cowpeas, or Bambarra beans, prepared as a dough or porridge, over which soup made with or without meat, is poured. In the mornings a light meal is taken off anything left-over from the previous evening; similarly at mid-day. When working in the farms at the beginning of the season cereal flour is taken mixed with drinking water. The results of a study of the diet of the Tallensi—a tribe around Tongo in Zuarungu Area—in relation to domestic economy, has been dealt with very fully by Dr. M. and Mrs. S. L. Fortes (9).

Recurrent Food Shortage.

262 251 241 It is not surprising that with a precarious rainfall and almost complete dependence upon cereals, crop yields are very variable and recurrent food shortage is a common experience. Soil erosion, and a system of continuous cultivation with inadequate manuring, have reduced the bulk of farmed land to a basic minimum of fertility, except in the immediate vicinity of compounds. The food problem is further complicated by a natural improvidence of the people whereby all crops are consumed in the year they are produced. In good years a surplus of grain is used lavishly in performing religious customs; it is seldom stored against the possibility of a bad season. A rise in the market value of crops at planting time suggests that many people are so improvident as not even to save sufficient seed for planting.

Famine Foods.

222 261 A reduced supply of cultivated foods in a poor season is eked out by food from wild sources. There is scarcely a single tree in populated areas which has not some value in this respect; and the seed of an indigenous grass, "Gonongo" (Nankani) (Dactyloctenium aegyptium), is laboriously collected and used as grain.

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Nevertheless, although a shortage of cultivated foods does not necessarily mean starvation, it lowers resistance to disease and saps the energy of the people at the end of the dry season when they need strength to prepare their farms; thus setting up a "vicious circle". It is not the shortage of food in itself which is so arresting, however, as the apathy of the people to the shortage. Ancestor worship causes them to dwell in the past and to think insufficiently of the present and the future. This, too, is probably symptomatic of the unsettled conditions when only the past was certain. It will take some time for the people, the older people who control affairs especially, to adjust themselves to the swift developments going on around them. An unfortunate result is that during the period of adjustment, many of the young men are attracted away from the district to work for wages in Ashanti and the Colony, where there is a big demand for unskilled labour in the mines and in handling the cocoa crop. These young men do not as a rule stay away from home for long at a time, and usually return with a little money; but they do not take readily to farming again, and represent a floating population which is the source of considerable concern to their elders.

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Economic Awakening.

An adequate food supply alone does not appear to be sufficient incentive for the adoption of better farming methods; and it is unlikely that changes will come until farming ceases to be regarded mainly as a custom, and becomes a business. There are many signs of an economic awakening, fostered by such factors as a growing desire of the people for imported commodities, and an increase in money consciousness; the completion of an all-weather road to the South; the opening of a gold mine at Nangodi; the developing trade in all classes of livestock with Ashanti and the Colony; the new trade in groundnuts from Bawku for the Kumasi market; together with the work of Government Departments in the improvement of human health, the health of livestock, and not least, the scope of the recently introduced Native Administrations. These are some of the factors helping to bring about a change which can be met only by better farming. Government must anticipate agricultural expansion to be in a position to control its development.

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The first problem, obviously, is to ensure a sufficiency of food for everyone in every year. Then, when local requirements have been satisfied, it must be shown how a surplus can be disposed of profitably, to satisfy growing demands. Upon this the Department of Agriculture is working in North Mamprusi, and the results of the last four years' work form the basis of this bulletin.

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7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Section II.—AGRICULTURAL SURVEY.

121 In this section it is proposed to record the methods adopted in studying local agriculture as well as to give the results of the survey.

Nature of the Problem.

As already mentioned in the introduction, our main object in coming to North Mamprusi was to investigate the causes of recurrent food shortage and to suggest and to implement ameliorative measures. It had been generally accepted that the shortage was due to the congestion of population; but it could not be said that more land was the solution of the problem until details of local methods of crop production were known; for the amount of food available depended as much upon the intensity of cultivation as upon the area cultivated. Efforts made in the past to encourage migration to the South had met with little success. Table I on page 8 shows that the density of population in Navrongo Area is only half that of Zuarungu Area, and yet the people in Navrongo Area suffer from food shortage. This suggests that simply to provide more land by encouraging emigration could at best afford only temporary relief, and that the problem is agricultural as well as political.

Survey Methods.

Information Required.

The information we set out to obtain before we could express an opinion upon the situation was as follows:—

1. Size of farms, man power expended and population supported per unit area.
2. The system of farming followed, with details of methods of cultivation, crop mixtures, rotations, areas under different crops, yields, and methods of maintaining fertility.
3. Economy of crops after production—storage, utilisation, disposal of surplus, market prices.
4. Position of livestock in the farm economy.
5. Natural vegetation and environmental factors in relation to food supply.

The scope of our work was limited by the staff available. Accuracy was considered to be of first importance, and quantitative data were collected wherever possible.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Approach to Problem.

Two methods of approach to the study suggested themselves. 121
The first, an intensive method, was to select an area and to take records from every compound within it and to survey all the land farmed by these compounds. The second, an eclectic method, was to select centres in different parts of the district and at each centre to select a number of compounds for detailed record. There were advantages in favour of each method but it was considered that, if care was taken in the selection of compounds, the second had more to recommend it for our purpose; this was the method adopted.

Selection of Centres for Record.

After discussion with the Political Officer for the district, centres of operation were considered, bearing in mind typicalness, accessibility, and the amenability of the Chief. The last is important for no matter how desirable a place might be for other reasons, no useful work could be done if the Chief was antagonistic. The centres finally selected were decided upon after touring the district. In all, records have been taken at ten centres distributed as follows:—

In Zuarungu Area in 1932 at Bongo, Nangodi, Sambruno, Tongo and Zuarungu.

In Navrongo Area in 1934 at Chana, Kologo, Wiaga, and in 1935 at Navrongo.

In Kusasi Area at Zebilla in 1936.

Selection of Compounds for Record.

At each centre a large number of compounds was visited with 124
a representative of the Chief, and from amongst these, six compounds were selected for record. Care was taken to choose compounds as typical of the district as possible. Thus the compounds of Chiefs, headmen, and strangers, were avoided if possible, and also the compounds of pensioners. Care had to be taken not to record the compound of a man pushed forward by the Chief simply to humour the white man. As with the Chief, so with the farmer, he must be amenable to our intrusion. The compounds we selected were probably rather above the average, and at Tongo we unwittingly included the farms of three headmen. At this early

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

124 stage in the survey, time spent in reconnaissance is certainly not wasted, for once records are started in a compound they must go on or be discarded; there is no time to change later.

Details Collected.

126 A junior officer of the Department was stationed at each centre and generally received the hospitality of the Chief. He was therefore in touch with the centre of local affairs. The number of compounds which can be recorded by one man depends upon many factors, but keeping strict accuracy in mind, rather than the maximum number of records possible, six was found to be a reasonable number for a man previously unacquainted with the work. Each compound was given a serial number, which was entered into a record book together with the place name, the name of the section and the name of the compound owner; these details were entered as a heading. Beneath this the following details were entered :—

Compound.

a. Number of men farming in the compound (including boys big enough to farm).

b. Details of persons supported by the produce from the farm.

c. Livestock owned by the compound.

d. Notes upon the food supply from the previous season.

e. Remarks. (Any details affecting the economics of the household, *i.e.*, trades followed, like smithing; money from sale of livestock; and so on.)

Farms.

f. Total area farmed (entered after survey).

g. Area, and a brief description of each farm.

h. Area of land manured in the current season (after survey).

i. Mean yields of major crops in current season (after harvest).

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Measuring Farms.

The total area of land farmed by each compound was then chain surveyed with the 100′ chain by the usual cadastral methods followed in agricultural survey (well described by Haines in "Surveying for Agricultural Students, Land Agents, and Farmers" (10)). The areas were then computed, and a plan to the scale of 1″=100′, was made of each "farm" (the word "farm" is used for each detached area or field). The farms were given serial numbers for each compound, and the plans were entered into the record book with notes upon situation, soil, and trees. All this is work which can be done during the dry season. 126

Measuring Crop Mixtures.

The next step was to make traced plans from the originals, on a separate sheet of paper for each farm. When dealing with a number of compounds it is essential to write the name of the place, the number of the compound, the owner's name, and the number of the farm, upon each sheet of paper, and to make certain that the staff recognise the same numbering. To avoid confusion the "compound farm" was always "Farm 1", and the others were numbered in order of the distance away from the compound. The traced plans were given to the assistant responsible for the centre concerned, and he entered-in the cropping when planting was finished. Where a number of different crops, or mixtures of crops, were planted in the same farm—as frequently happened, particularly in compound farms—the boundaries of each were marked in on the traced plans with dotted lines. The area of land manured was marked-in by shading. The position of these boundaries was found by running intersection lines from the original survey pillars (marked by stakes in the ground). This work has to be done and checked before the crops have grown so high as to be damaged by chaining.

Computation of Crop Areas.

The areas of each mixture of crops were then calculated. Where a whole farm was planted with a single mixture the area of the farm was the area of the crop, less any land occupied by buildings, etc. In farms which contained a number of mixtures, where only the total area was known, the area of each mixture was found, accurate to the first place of decimals, by graphical methods (10) from the traced plans. Hence the need for scale plans of farms. (To compute the area of a piece of land from a scale plan,

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

126 proceed as follows: Draw parallel lines 1" (=100') apart in ink upon a piece of tracing cloth, or tracing paper. Place the lined tracing cloth over the plan, the area of which is required, so that one boundary touches a parallel line. With a transparent set-square, lay off "give and take" line at right angles to the lines on the tracing cloth, to equalise the boundaries on the plan. Measure the distances between opposite equalising lines, add, and multiply by 100; this gives the area in square feet. If "give and take" lines are entered lightly in pencil they can be erased and the tracing cloth can be used almost indefinitely.)

Collection of Yield Data.

It was not feasible to weigh all the produce from the farms in order to obtain yield data since crops were harvested irregularly. Neither was it desirable, provided a sufficient number of sample plots could be laid down at random in average parts of the fields. The method adopted was to demarcate at least two square plots of one-fortieth acre (33' x 33') in every acre of the farm; the corners of each plot were marked with stakes and the boundaries with a shallow hoed line. The position of these plots was marked roughly on the cropping plans, and each plot was given a serial number for the farm, in order, radiating out from the compound. By reference to the place, compound number, and plot number any matter relating to single plot could be checked immediately

Cropping Schedules.

Cropping schedules were next prepared for each compound, into which the yields were entered at harvest. The schedules were made on lined foolscap paper and contained as a heading the place name and compound number, and columns from left to right giving—Farm No., Plot No., Cropping, Date of Planting, Date of Harvesting, Yield per Plot, Manuring, Remarks. Considerable importance was attached to the "Remarks" column into which was entered anything to explain why the yield from the particular plot in question should be high or low.

Method of Recording Yields.

Yields were weighed to the nearest quarter of a pound upon a "family" type of spring balance. Cereal crops were recorded as dry head weights, and a sample was set aside to give the threshing percentage. Groundnuts were recorded "dry in shell", and

7:Lynn G-5 (1932-1936) 1937 FE11 Talleñsi FE11

sweet potatoes and Coleus potatoes as fresh tubers. Harvesting and weighing had to be left to the junior staff, but visits were paid as often as possible to each centre of record during the harvest season and check weights were taken. It is essential that the staff fully understand what is required of them before the rush of harvest comes on. Any doubtful yields must not be recorded. Nearly half the records in 1932 had to be discarded because a "literate helper" thought it better to put down fictitious yields than to report mistakes. At first some farmers thought we intended to confiscate the produce from the sample plots; but they all readily co-operated with us when disillusioned. 126

Results of Survey.

Distribution of Recorded Compounds.

The farms of 54 compounds have been surveyed and it is upon the data from these that the following statistics are based. The variation from one compound to another, in almost every detail recorded, makes it necessary to emphasise that, whilst the figures are reasonably accurate in themselves, they are based upon a very small proportion of the population, and the means are reliable as district means, only as our compounds are typical of the centres from which they have been selected. The compounds were distributed at the ten centres of record as follows :— 128

Zuarungu Area.	Bongo	6
	Nangodi	5
	Sambruno ...	5
	Tongo	5
	Zuarungu ...	8
Navrongo Area.	Chana	6
	Kologo	6
	Navrongo ...	2
	Wiaga	6
Kusasi Area.	Zebilla	5
	Total	54

In discussing the results of the survey work it is proposed to reduce figures in the text to means and percentages as far as possible; details are given in tables in Appendix II.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Types of Farm.

Farms are of three types:—

24
311

1. Compound Farm. This is the original farm and the most important. It is dressed with any manure which may be available and invariably receives attention first. Size and shape is very variable; average size, 4.89 acres.

2. Farms separate from compound farm but not "bush". These are generally small areas between compound farms, very irregular in outline and farmed less intensely than the compound farm; average size 1.35 acres.

3. "Bush" Farms. These are extensively cultivated farms, away from compounds, often upon stony hillsides. They receive the minimum of attention. The average size of bush farms is 1.74 acres.

Analysis of Areas Cultivated.

Of the land cultivated by 54 recorded compounds, 61% of the total area cultivated was compound farm; 17% farm away from the compound but not in bush; and 22% was bush farm (see Appendix II, Table 4). Not every compound had each kind of farm, however:—

10 compounds (18%) had compound farms only, with an average of 7.47 acres.

22 compounds (41%) had compound farms with an average area of 4.51 acres and in addition farms away from the compound (but not "bush" farms) average area 2.07 acres.

14 compounds (26%) had compound farms of an average area of 4.36 acres and "bush" farms of 4.56 acres.

8 compounds (15%) had compound farms with an average area of 5.89 acres; farms away from the compound but not bush—2.35 acres—and bush farms—5.75 acres.

Bush farms were found at Nangodi, Tongo, Kologo, and Zebilla; none at Bongo, Chana, Sambruno, Navrongo and Wiaga. Two compounds at Zuarungu, on the Nangodi road, had bush farms in the hills. The treatment of different types of farms will be discussed below under the headings for crops and yields.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Man Power and Persons Supported.

Two figures of primary importance to the study of agriculture in its particular relationship to food-supply and density of population are, (i), the area of land cultivated per man working; and (ii), the area of land cultivated to support a unit of population. These figures, when taken into consideration with the system of farming followed, and the agricultural potentialities of the district, form the basis and starting point for ameliorative measures. Statistics are given for every compound surveyed, in Appendix II, Tables 1—3. These are summarised in Appendix II, Table 4, from which the following data have been extracted.

241
311

1. The total area of land cultivated by 54 compounds was 431.08 acres. This gives an average area cultivated per compound of 7.98 acres.

2. The number of men farming 431.08 acres was 173; average area cultivated per man farming—*2.49 acres.*

   (Note. Boys big enough to hoe are included as "men farming". Women and children also assist, particularly with planting and harvesting.)

3. Total number of persons supported on 431.08 acres was 650 (this figure includes children, but not babes in arms); average area cultivated per person—*.66 acres.*

4. 173 men supported 650 persons; 1 man supported 3.7 persons.

5. An average compound farmed 7.98 acres, of which 61% may be compound farm, 17% away from the compound but not bush, and 22% bush farm. This area is farmed by 3.2 men and supports 12 persons.

It is interesting to observe that if these figures are taken as being representative of the whole of North Mamprusi, about one-eighth of the district is under cultivation.

Crop Husbandry.

Crops Grown and Methods of Cropping.

241

All crops grown in the district are annuals of which the cereals, early millet, late millet, and guinea corn, occupying over 90% of the cultivated land (see Table 2, below), are by far the most important. A list of the crops more commonly grown is given in

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

241 Appendix III with their Nankani, Kassena, and Builsa names. Mixed cropping is the general practice with all except root crops and tobacco. Proximity to the compound, and the nature and fertility of the soil, determine the crops to be planted on any given area. The cropping most commonly found upon the three types of farm is as follows :—

(i) *Compound Farm.*

The standard cropping upon fertile land—land sometimes manured—is early millet mixed with guinea corn, alternated with early millet and late millet. Further from the compound where land is seldom manured, guinea corn alternated with late millet is planted without early millet. This alternation of the late cereals is the only rotation followed. Under guinea corn and millet, whether planted in a mixture or alone, cowpeas and "neri" (Cucumis melo) are invariably planted as ground crops. Minor crops planted in small quantities in compound farms are: maize, intercropped upon old midden sites near the compound; Hibiscus cannabinus in small beds, a soup plant "Nangina", Nankani (Gynandropsis pentaphylla), and sometimes tobacco, near to the compound wall; groundnuts upon sandy soil away from the compound and Bambarra beans on gravel; rice in small patches, sweet potatoes and Fura-fura potatoes (Coleus dysentericus) in ridges or beds, in wet parts of the farm. Odd plants of pumpkin (Curcubita pepo), sesamum, and cassava, are sometimes intercropped around the compound; whilst over the compound itself, calabashes (Lagenaria vulgaris) are trained. Small beds of the earth bean, Kerstingiella geocarpa, and tiger nuts (Cyperus esculentus), are sometimes planted on the margin of the farm. Along the sides of all paths and farm boundaries Hibiscus sabdariffa is planted.

During the rains, as can perhaps be imagined from the above description, the compound farm presents an amazing scene of heterogeneous crop growth, in marked contrast to the bareness of the dry season. There is no part of the farm, other than that occupied by buildings, paths, and occasional grazing areas, which has not something planted upon it. The method of planting is very haphazard, and this, and the filling of blanks in a mixture with some other crop, greatly complicates the cropping plans. A compound farm may have as many as a dozen different mixtures of crops upon it, planted on areas from as small as .01 of an acre, upwards.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

(ii) *Farms Separate from the Compound Farm, but not in "Bush".* 241

These farms are seldom manured and only rarely are they sufficiently fertile to grow a crop of early millet as well as another cereal; they are treated in the same way, therefore, as those parts of the compound farm which lie outside the sphere of manuring. If there is no land in the compound farm suitable for groundnuts, the farm may have been specially selected for this crop. The general treatment of these farms is the same as that described for the compound farm; but since no early millet is planted, there is no great hurry at the beginning of the season and the farm receives attention when work on the compound farm is well in hand.

Under this heading should be mentioned the dry season tobacco cultivation on the river flats between Bolgatanga and Winkogo and, to lesser extent, at Sambruno and elsewhere. This is a specialised cultivation of importance in these places. The land is fertile because it receives some of the goodness leached out from the surrounding country. In a season when rains fall early, a crop of early millet may be taken off before the land becomes water-logged. In August and September tobacco seed-beds are prepared; the seedlings are transplanted in October and November as the water-table recedes. The tobacco is harvested in January, February, and March. 249

(iii) *Bush Farms.*

Bush farms are found only in areas where unoccupied land is not more than a mile or two away from the compound. They are frequently made on hill-sides where the soil is shallow and weed growth is not very vigorous. Little is done beyond planting the seed and giving a single hoeing. Guinea corn and cowpeas alternated with late millet and cowpeas is the usual cropping until yields fall off; the farm is then left to recuperate for a few years. In a lucky season fair yields may be reaped, and any yield is considered a good return for the small amount of labour expended. It is necessary to mention that in the south of Kusasi Area, and in the south-east of Zuarungu Area, yams are grown in bush farms, and the system of farming followed is typical of South, and not North, Mamprusi. 241

An analysis of the distribution of crops at the ten centres of record is given in Appendix II, Table 5. From this table the following summary (Table 2) has been taken. It shows the crops, and mixtures of crops, and the proportion of the total area cultivated under each, expressed as a percentage for the total area cultivated by 54 recorded compounds. The area manured, as a percentage of the total area cultivated, is also shown.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

241

Table 2.—Summary of analysis of cropping and manuring on 431.08 acres farmed by 54 recorded compounds in North Mamprusi.

Crops or Mixture of Crops	% of total area cultivated (approx.)	% manured	Type of farm
Cereals— Early millet, Late millet, Ground crops*	16%	4.7%	Compound
Early millet, Guinea corn, Ground crops	16%	3.7%	Compound
Early millet, Late millet, Guinea corn, Ground crops	18%	3.8%	Compound
Late millet, Ground crops	16%	—	Bush and compound
Guinea corn, Ground crops	16%	.45%	Bush and compound
Late millet, Guinea corn, Ground crops	4%	—	Bush and compound
Rice	1%	—	Compound
Maize	.04%	.02%	Compound
Late millet**, Groundnuts	4%	—	Compound
Total Cereals	91%	12%	
Legumes—			
Groundnuts	5%	—	Compound
Bambarra beans ...	.2%	—	Compound
Groundnuts ..., Bambarra beans	3%	—	Compound
Kerstingiella geocarpa	.1%	—	Compound
Total legumes ...	8%	—	
Root crops—			
Coleus (Fura-fura) potatoes	.5%	—	Compound
Sweet potatoes ...	.1%	—	Compound
Total Root crops	.6%	—	
Miscellaneous— Tobacco, Okro, Hibiscus cannabinus	.1%	—	Compound

*Ground crops—Cowpeas and 'neri.'
**Could also be included under 'Legumes.'

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Manuring.

241

It has already been mentioned that manuring forms a definite part of the farming system; there is scarcely a single compound which has not a compost heap of some kind in front of it, and everyone is familiar with the value, and the use, of manure. It is surprising, therefore, to find no great attention paid to either quality or quantity. Table 2, column 3, shows that 12% only of the total area cultivated received a dressing of manure in the year of survey. The manure (compost) consists of household sweepings, that is, the dung from livestock mixed with vegetable waste; but the amount of manure which is accumulated in this way is very small by comparison with the amount which could be made if a little more care was exercised in its preparation. Women and children carry the manure from the midden in baskets and put it on to the land in small heaps, just before, or just after, early millet is planted. From these heaps it is spread around at the next hoeing. The baskets hold from 4 to 15 lbs. and the heaps are made from 6′ to 8′ apart; this gives an average dressing of from 2 to 5 tons per acre. The yield figures (see Tables 3 and 4 below) leave no doubt as to the value of these small dressings of manure. Undesirable as it may be from a sanitation point of view, the vigorous growth of crops around compounds and near to markets, suggests that nightsoil plays no small part in the maintenance of soil fertility (a point which should be remembered when considering the provision of latrines: a septic tank used to compost vegetable waste is much to be preferred, where practicable, to pit latrines and incineration).

Implements.

412

The agricultural implements used by a people are generally a good index to the standard of their agriculture. This is certainly true of the implements used by the people in North Mamprusi: they are very rudimentary and the standard of cultivation is low. The hoe, with which most of the work is done, consists of simple oblong-shaped iron blade, 7″ long and 5″ wide, slightly concave on its inner face. The middle of the top of the blade is drawn up into a ring, this is forced on to the tapered end of a short hooked stick which serves as a handle; the whole weighs under 2 lbs. The blade is set on to the handle at an angle of about 85°, and the hoe is used by working it towards the body. The handle is about 1½′-2′ long, made generally from "ginga" (Nankani) (Diospyros mespiliformis), or "gopelaga" (Acacia sieberriana). For chopping, or cultivation in particularly hard ground, an adze is used; this is made of heavier iron than the hoe, 1½″-3″ wide and 4″-6″ long,

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

412 mounted on a similar handle. Hoe-blades are now made from scrap iron, mainly parts of old motor cars and old railway sleepers; [177] a hoe is sold in the market for 2d. or 3d., which is well within the purchasing power of everyone. It is not many years, however, [326] since hoes were made from locally smelted iron; they were then not so easy to come by and some of the poorer farmers used hoes of hard wood.

241 The coarse nature of the soil enables a shallow cultivation to be given effectively with these light implements after a fall of rain. 134 When the ground is dry and hard, cultivation is very laborious and it is frequently neglected at a time when needed most. This is often the case early in the season when precarious rains make a soil-mulch desirable.

Preparation for Planting.

243 Two of the most important crops, early millet and guinea corn, are sown after the second big rain of the year, this is generally in the first week of April. The soil, which has been left untilled since the burn-over after the previous year's harvest, is very hard until humidity rises with the approaching rain, and there is very little time to do any preliminary cultivation. On the majority of farms the only preparation for sowing is to collect the remains of the previous season's crops into heaps and to burn, and sometimes to carry-out manure; very occasionally a little hoeing is done.

Planting Major Crops.

412 On the morning following the big planting rain the whole countryside turns out to do one of its few really full day's work 241 on the farm for the year. Men walk over the farm with stout sticks about 6′ long, cut from "tcheea" (Nankani) (Anoegeissus leiocarpus), or "gopelaga" (Nankani) (Acacia sieberriana), sharpened at the end to a flat point, resembling a narrow-bladed oar; or sometimes fitted with a worn hoe blade. With these sticks, holes are prodded at random 2′ 6″ to 3′ apart in the moist earth; 241 the soil being ejected with a twist of the wrists. Women and children follow the men with the seed of early millet and cowpeas mixed in a calabash. The calabash is held in the hand between the third and fourth fingers, and three to six seeds of early millet,

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

and occasionally one or two of cowpeas, are deftly ejected into each hole with the thumb and first fingers; both early millet and cowpeas are sown in the same hole. The seed is then lightly covered with soil and made firm by treading as planting proceeds. It generally takes two or three days to finish sowing early millet, and if the ground is still soft enough, guinea corn, mixed with "neri", is sown immediately, in exactly the same way as early millet and cowpeas, in the spaces between. When the sowing of guinea corn is finished in the compound farm, late millet is sown; it is also used for filling blanks in guinea corn. Attention is next given to the farms away from the compound. All cereals, except rice, are planted by the beginning of May, in a normal season.

Planting Minor Crops.

At the end of April or early in May women plant "bersi" (Nankani) (Hibiscus cannabinus), okra, and "nangina" (Gynandropsis pentaphylla), in beds close to the compound, and "bito" (Hibiscus sabdariffa) at intervals of 2′ beside paths and along farm boundaries. Towards the end of May, groundnuts are planted 6″ to 18″ apart in a manner similar to cereals, except that frequently the land is hoed first. Bambarra beans are planted next, either on the flat, or if the land is wet, on wide ridges. Coleus potatoes and sweet potatoes are planted on ridges in June. Rice is sown at the end of June, alone, or occasionally between guinea corn on wet land; when the water-table rises in late July, rice is thinned and transplanted as opportunity permits. This is also the time for thinning and transplanting late millet; a common practice is to transplant it into groundnut farms. Tobacco seed beds are prepared and sown in August, and the seedlings are transplanted in September and October for the dry season crop.

Crop Varieties.

A number of crop varieties are recognised and although many of the names distinguish only colour factors, other factors, such as earliness of maturity, particular uses, predilection for certain kinds of soil and manure, are known and utilised. With guinea corn, for instance, over a dozen varieties exist.

Cultivation.

Intercultivation starts as soon as crops have germinated, and any manure which was not carried before planting, is applied at this time. Cultivation consists of scraping the top three or four

241 inches of soil. Because of the haphazard method of planting, great care has to be exercised not to damage the young plants. The work is tedious; and the grain stores at this season of the year are [461] at their lowest (9); seldom is a man prepared to work for more than two or three hours at a time, and the maximum area cultivated in a day is about $\frac{1}{10}$th acre. Hoeing is started near to the compound and works outward; by the time the bush farm is reached the crops there are almost choked with weeds, and commonly they receive a set-back in their early stages from which they never [471] recover. A farmer fortunate enough to have a good supply of grain may call his neighbours to assist with hoeing, in exchange [473] for food and "dam" (Nankani), the local guinea corn beer. Or farmers may take turn about to work on each others' farms. In a few cases labour is hired and paid money wages.

243 On land where early millet is planted it is usual to give three hoeings; two before harvesting early millet, and a final one to earth-up the late cereal afterwards. Land planted with a single cereal, guinea corn or late millet, is generally hoed only twice; or, in the case of some bush farms on the hills, once only.

Harvesting, Methods and Times.

241 Early millet is the first crop to be harvested, at the end of June or beginning of July, having occupied the ground for about 243 80 days. When mature, this crop is from 5 to 7 feet high; at this stage the interplanted late cereal is 3 to 4 feet high, and ground-crops are beginning to make a cover. It is common to pluck a few heads "green" for immediate consumption, but the grain is allowed to harden before the main harvest. During this period birds become a serious pest; children spend the day scaring them and women carry rattles, made from pieces of broken pottery threaded on to a thin stick.

The heads of millet are cut off at the neck by men using short knives, and women carry the crop in baskets to the compound to [242] dry. The best heads are selected for seed; second grade heads are stored, unthreshed, in a granary (see diagram by Muir and Williams (4)) and threshed as required for use. Poor heads—"konkoni" (Nankani)—are boiled, threshed, and stored in pots; this grain is used for thickening soups. When all the early millet 252 heads have been gathered, women pull up the remains of the plants and transport them to a flat rock, where they burn them slowly to obtain the ash, which is carefully collected in pots. The ash

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

is used in preparing tobacco for chewing, and also, by percolation, "coom missom" (Nankani), literally "sour water", which is used in cooking cereal foods. The salts in the ash probably supply important minerals to the diet (11), but the process by which they are obtained, robs the soil of much of the manurial value in the residue of the early millet crop. 252 [146]

The leaves of cowpeas are picked by women throughout the growing season and used in making soup. Maize is harvested towards the end of July, followed by "neri". The fruits of neri are buried in the ground for about ten days to rot the pericarp; they are then dug up, washed by women in a stream, and the seeds are dried and stored in pots for future use. Early guinea corn is reaped at the end of August and in September, by which time late millet and the main guinea corn crop are coming into flower. At this season, women and children strip all the leaves and sepals from Hibiscus sabdariffa and, after careful drying, store them in pots for making soup during the dry season. The leaves of Hibiscus cannabinus are similarly treated, and the end of the branches, bearing fruits, are cut off and later the seeds are removed for soup making. The bast fibres of both Hibiscus sabdariffa and Hibiscus cannabinus are drawn after retting in streams for 10 to 12 days: they are made into rope of good quality; this work is generally performed by men. Women also draw the fibres of Hibiscus cannabinus, and scrub them white for making the "tails" they sometimes wear as alternative dress to leaves. 241 251 248

The main harvest season starts during the middle of September with groundnuts, and is carried on through October, and into early November, with guinea corn and late millet. During this period, from a peak in August, the rainfall decreases and the water-table falls; with the onset of the harmattan in November, the whole countryside dries rapidly. The groundnut plants are lifted with a hoe, and carried to the shade of a tree, where the nuts are picked off; the hay is carefully conserved as a dry season fodder. The day previous to reaping the late cereal, cowpeas are collected and carried to the compound; the leaves and stems are also conserved for fodder. The heads of late millet and guinea corn are cut off in the same way as those of early millet, and the stems are trampled to the ground. For about three weeks after harvesting, livestock are given open range in the farms and they feed readily upon the still succulent leaves of guinea corn and, to a less extent, millet. But as soon as the material is dry enough, fire is put through the farm to burn off the trash from the resistant cereal stalks, leaving them slightly charred, and clean: in this way much valuable dry season fodder is destroyed. The stalks are chopped from their 241

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

241
[372] The stalks are chopped from their roots with an old hoe, collected into bundles, and stacked near the compound for use as fuel in the dry season, and for building purposes. Throughout the dry season the ground is hard and bare, except for the roots of cereals lying about; it remains in this condition until the farming cycle starts again with the approach of rain in the following year.

Yields of Crops.

The methods by which yield data were collected have already been described on page 16. The yields from nearly a thousand sample plots have been recorded at the ten centres in North Mamprusi during the years 1932, 1934, 1935, and 1936. These yields have been analysed according to district, year of record, and whether or not the plots were manured in that year, and the analysis is given as Tables 5 and 6 of Appendix II. The number of sample plots from which each mean was obtained is given in brackets, as an index of reliability. (Unfortunately it is not possible to give standard errors of the means since the first recorded individual plot yields have been mislaid and only the mean yields and the numbers of plots were placed on record.) It will be seen from this table that wide fluctuations in yield occur from year to year and from one district to another in the same year. 1932 and 1936 were generally recognised to be good years and it is interesting to note that in both these years the rainfall curves were very similar. They show: showers of rain in February; good planting rains in early April, with curves rising to peaks in May, and then falling slightly at the end of June for the ripening of early millet; after that a steady rise to second peaks at the end of September, instead of August, which do not fall quickly until the end of October. The year 1934 was considered to be rather below the average due to shortage of rain, both early and late in the season, and an excess at the time early millet was ripening. From Table 5 in Appendix II the mean yields for the more important mixtures of crops have been taken and these are given in Table 3 opposite to the nearest 5 lbs. per acre; this table should be considered in conjunction with Table 2 (text). Yields from plots which were manured in the year of record are classified as such; it was not possible to consider either the quality or the quantity of manure applied in relation to yield. The remarkable effect of quite small dressings of native compost (see page 23) upon yields is noteworthy.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

241

Table 3.—Summary of the mean yields for the more important mixtures of crops in North Mamprusi. Records taken over a four year period 1932-1936.

(From Appendix II, Table 6.)

Crops	Mean Yields per acre		
	Unmanured	Manured	
Early millet	320	455	lbs. grain
Late millet	405	420	lbs. grain
Cowpeas*	60	80	lbs. seed
Neri	40	30	lbs. seed
Early millet	295	555	lbs. grain
Guinea corn	370	525	lbs. grain
Cowpeas	60	80	lbs. seed
Neri	40	30	lbs. seed
Early millet	280	505	lbs. grain
Late millet	150	95	lbs. grain
Guinea corn	260	460	lbs. grain
Cowpeas	60	80	lbs. seed
Neri	40	30	lbs. seed
Late millet	240	—	lbs. grain
Cowpeas	60	—	lbs. seed
Neri	40	—	lbs. seed
Guinea corn	355	—	lbs. grain
Cowpeas	60	—	lbs. seed
Neri	40	—	lbs. seed
Late millet	120	—	lbs. grain
Guinea corn	110	—	lbs. grain
Cowpeas	60	—	lbs. seed
Neri	40	—	lbs. seed
Late millet	145	—	lbs. grain
Groundnuts...	690	—	lbs. dry in shell
Rice	690	—	lbs. paddy
Groundnuts...	635	—	lbs. dry in shell
Bambarra beans	490	—	lbs. dry in shell
Groundnuts...	565	—	lbs. dry in shell
Bambarra beans	150	—	lbs. dry in shell
Coleus potatoes	3,361	—	lbs. fresh tubers
Sweet potatoes	5,313	—	lbs. fresh tubers

*The weights of 'ground crops', cowpeas and 'neri', were calculated irrespective of mixture.

241 In order to demonstrate the annual variation in yields more clearly and the performance of individual crops, the yield of each of the more important crops has been calculated from Table 6, Appendix II, irrespective of the mixture in which it was grown; these yields are given in Appendix II, Table 7. Provided that the proportions of crops in the mixtures were fairly constant from year to year, the figures have a comparative value. From Appendix II, Table 7, the district means obtained in each year have been calculated to the nearest 5 lbs. per acre, and these are set out below in Table 4:—

Table 4.—Summary of mean yields of each of the more important crops, irrespective of mixture, for the years 1932, 1934, 1935 and 1936. Figures in lbs. per acre.

(From Appendix II, Table 7.)

Crop		1932	1934	1935	1936	Summary for all years
Early millet ...	Unmanured	355	230	365	300	270
	Manured	525	385	605	505	505
Late millet ...	Unmanured	350	195	175	255	235
	Manured	430	205	60	220	225
Guinea-corn ...	Unmanured	395	230	320	495	325
	Manured	530	400	415	680	485
Groundnuts ...	Unmanured	490	630	725	685	595

The mean yields for 1936 given in the above table are lower than the means for Zuarungu and Navrongo since they include those from Zebilla in Kusasi Area. Zebilla suffered badly from a shortage of rain early in the season, which depressed the yield of the early crops; the guinea corn recovered well, however.

Methods of Storing Crops.

251 343 Cereals in bulk are generally stored unthreshed, in conical shaped granaries; the day's allowance is given to the women each morning by the head of the compound, and threshed as required. These granaries ("bari", Nankani) are made of "swish" proofed with cowdung and an infusion of the empty pods of Parkia filicoidea ("nam", Nankani); they are built inside the compound in Navrongo and Zuarungu Areas, and generally outside the door of the compound in Kusasi Area. In size they vary from 4′ to 6′ in diameter at the base, and from 6′ to 10′ high. A diagram of a section through a granary is given in Muir and Williams' paper (4).

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

(4). Small quantities of seed and soup ingredients are stored in earthenware pots and calabashes of different shapes and sizes, which can be sealed with mud and cowdung. Ashes are mixed with cowpeas to discourage attacks from weevils. Groundnuts are generally stored in big baskets, plastered on the outside with mud and cowdung. 251

Animal Husbandry.

The importance of livestock in maintaining a system of fixed cultivation, under the conditions described, is patent. Furthermore the importation from French territory of large quantities of cattle, sheep, goats, and fowls, is a good indication of the size of the market for meat in Ashanti and the Colony; there is no reason why a greater proportion of this market should not be satisfied from local sources than is at present supplied, with benefit to the local farmer. In recognition of this, Government has pursued a policy of general immunisation against cattle plague, which is now practically complete. As a result, the cattle in North Mamprusi are shown to be increasing very satisfactorily (12) since the initial immunisation in 1931-32. From a census taken in 1936 they were found to number over 64,000 head. Thus over one-third of the cattle in the Northern Territories (64,293 head out of 160,000) are being maintained upon less than one-tenth of its area (3,559 sq. miles out of 41,940 sq. miles). The growth of the cattle population, taken into account with the numbers of other livestock, and the shortage of water and of human food in some years, gives some idea of the magnitude of the animal husbandry problems which lie ahead. 231 744

Uneconomic Position of Livestock.

Livestock occupy a peculiar position in local farm economy. Although they are sold in order to get money when necessary, nevertheless, they are not reared for economic purposes, but primarily for religious sacrifice and the payment of marriage dowries. In North Mamprusi, wealth and position are associated, not with money, but with the number of wives and children, and livestock, that a man has. Four cows would enable a man to acquire another wife, but ten pounds would not do so (by custom). As with crop husbandry, so with animal husbandry, economic conditions are changing more rapidly than custom is adjusting itself; unless the adjustment receives careful assistance there is a grave risk of loss of soil fertility and human stamina, on the one hand, and the constitution of the livestock upon the other. 231 182

Numbers of Livestock Owned per Compound.

The numbers of livestock owned by recorded compounds are set out in Table 8, of Appendix II, in detail. From this table text Table 5 below has been extracted. 231

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

231

Table 5.—Livestock owned by 54 recorded compounds in North Mamprusi.

(From Appendix II, Table 8.)

Stock	Total owned by 54 compounds	Compounds owning each class of stock		Mean per compound assuming all owned stock equally (approx.)
		No.	% (approx.)	
Horses	2*	2	—	—
Cattle	105	29	54%	2
Donkeys	26	18	34%	1
Sheep	183	31	58%	3
Goats	235	42	78%	6
Fowls	567	47	87%	11
Guinea Fowls ...	359	36	67%	7
Nil	—	2	4%	—

*Owned only by Chiefs, or members of the chiefs' families.

It will be noted that 4% of compounds had no livestock at all at the time of record. Records were taken in March and April at a time when stocking was low, following a poor season; more stock than usual had been sold in order to purchase food. As might be expected, the amount of livestock owned by a compound is very closely correlated with the supply of foodstuffs; all compounds short of food in the year of record had livestock in numbers below the average. The area of land manured and the number of livestock owned did not show such a close correlation as was expected, but the close connection between the two is obvious.

Cattle.

The cattle are humpless, and well named "West African Shorthorn" (13), for, except that they are much smaller—adult bullocks averaging little more than 5 cwts. in weight—they resemble a Shorthorn very closely. In size, good bullocks measure from 44 to 46 inches in height at the withers, 41 to 45 inches in length, taken from the top of the shoulder blade to the root of the tail, and have a minimum girth behind the shoulders of from 61 to 65 inches. A variety of colour factors suggests great heterogeneity. Very pleasing animals are occasionally seen; they are stocky, with straight back-lines, and of good conformation. That such animals can be found in the unimproved environmental conditions obtaining locally, augurs well for the future. The Animal

The Animal

Health Department have done much good by castrating scrub bulls, but unfortunately the farmers themselves have carried the matter further, to a dangerous degree, by castrating many of the remaining bulls in order to sell them to itinerant butchers' agents. This trade has developed rapidly during recent years and the services of any bull at all, let alone a good bull, are not always readily obtainable. The difficulty is that the cattle are owned one or two head at a time and rarely in herds, and a farmer who wants money, and has a bull he can sell to obtain it, does not see why he should keep a bull to serve his neighbours' cows, and is prepared to risk his own cow, or cows, not finding a mate. The supply of bulls is a matter receiving the attention of the Animal Health Department, through the Native Administrations.

Tending of Livestock.

The farmers' attitude to livestock is typified by the fact that herding is the responsibility of small boys. The stock are housed at night in an open compartment within the compound. No bedding is supplied and the unbeaten floor of the standing is only irregularly cleaned out; the result is a very unhealthy mess in the rains. Except to save groundnut and cowpea hay for feeding to horses and donkeys, no provision is made for dry season fodder. The stock are turned out to browse where they will over the stubble and upon recognised grazing grounds between farms; but since these are generally burnt over, the fodder supply is sparse in quantity and poor in quality, and all stock show considerable loss of condition as the dry season advances, particularly in years when rains are late. The supply of water also presents a problem in many areas. In the rains, sheep and goats are generally tethered to short stakes along farm boundaries, and cattle are herded on the grazing grounds.

Fowls.

Of all classes of livestock probably fowls receive most attention. They are able to pick up a fair living by gleaning around threshing floors, and the protein constituent of their diet is obtained largely from white ants. These are collected with cowdung placed in an old pot inverted over an ant run in the soil. There is scarcely a single compound in North Mamprusi that does not engage in the export trade in fowls to Kumasi. In the dry season a man will collect together about twenty-five fowls at a time and head-load them in a long crate to some market on the road, usually Bolgatanga, or Savelugu, and either sell them to a middleman there, or join a lorry and sell them in Kumasi. With the proceeds from the sale of fowls, it is common to purchase grain in Dagomba or South Mamprusi, to re-sell in Navrongo or Zuarungu Area, and thus to show a profit upon both the journey down, and the journey up.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Section III.—DISCUSSION OF FINDINGS IN PARTICULAR RELATION TO FOOD SHORTAGE.

262 The remarks made in this section apply more particularly to the Zuarungu and Navrongo Areas than to Kusasi, because, generally speaking, the Kusasis seldom suffer from food shortage and, indeed, they frequently have a surplus for disposal. For this reason the agricultural problem is more acute in the Zuarungu and Navrongo Areas; an adequate and reliable food supply is a prerequisite of all development.

Nature of Food Shortage.

262 Enquiry showed that, as far back as memory goes, a shortage
251 of cultivated foods is experienced in about two years out of every five; the problem, therefore, is by no means a new one. Hungry years follow seasons of poor crops, since practically nothing is stored for more than eight months, *i.e.*, from the time of the main harvest in October and November, until early millet is harvested in the following July. A surplus in a good season is not stored against the possibility of a bad one, but is used lavishly in the performance of religious customs, or it is sold or bartered for livestock. Livestock may be regarded as a kind of bank; the sale of stock is the usual means of obtaining money. In years of food shortage, livestock are sold in order to buy grain from Kusasi, Mamprusi, or Dagomba; and because a number of people are selling at the same time, livestock values fall very considerably in these years.

262 Although bad seasons result in food shortage for many, they
222 do not necessarily mean starvation, for there are a number of wild sources of food which can be used to eke out a reduced supply of cultivated foods. The most common causes of poor crops are abnormal rains and the ravages of locusts. In good seasons, such as 1932 and 1936, very few people suffer from a shortage: the area of land cultivated is adequate, presumably, and the system of farming is successful. But even in bad seasons it is not everyone who is short. Thus out of the twenty-nine recorded compounds in the Zuarungu Area, ten had sufficient home-grown food remaining from the bad harvest of 1931 (due to shortage of rain after September) until early millet was reaped in 1932. The other nineteen compounds sold livestock and bought grain, and gathered "wild" food. A comparison of statistics from these compounds is given in Table 6 below:—

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Table 6.—Comparison of statistics from ten compounds in Zuarungu Area which suffered no food shortage in 1931-32, and nineteen compounds which suffered from a shortage.

	Means from 10 compounds with no food shortage.	Means from 19 compounds short of food.
Area of land farmed per compound	8.16 acres.	5.66 acres.
Men farming	3.4	3.4
Area farmed per man	2.4 acres.	1.68 acres.
Persons living in compound ...	14.7	11.5
Area cultivated per person ...	.55 acres.	.49 acres.
Persons supported per man farming	4.3	3.4
Units of livestock (March, 1932) ... (Fowl=1 unit.)	399	136

From Table 6 it will be seen that compounds which suffered from no shortage were bigger in almost every particular than compounds which suffered (c.f. district means, Appendix II, Table 4). Observation throughout the 1932 season showed that the farms of the ten successful compounds were better cultivated, and the owners had the reputation for being good farmers. A study of yields, however, showed no appreciable difference in favour of the successful farms; but as already mentioned, 1932 was a very good season for crops in Zuarungu Area, and none of our compounds suffered from a shortage of food during the following dry season. This suggests that under the present system of farming, the major factors determining yield are those lying outside the farmers' control; the most important of these are the amount and distribution of rainfall. The effects of better farming are more marked, therefore, in a bad season than in a good one. It is probably this fact, together with a knowledge of "wild" sources of food, which has resulted in a system of farming which demands the minimum amount of labour from the farmer, and leaves the maximum to Nature; for Nature, in the shape of a "fetish", can be placated by the simple expedient of sacrifice.

Causes of Food Shortage.

Indirect Causes.

Food shortage has been ascribed to a lack of land resulting from a concentration of population, and land settlement schemes have been suggested as the solution of the problem. But the concentration of the population is responsible only indirectly, and only for as long as the system of farming remains unchanged. It

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

is doubtful whether, given unlimited land, the local farmer would be prepared to devote any more time to cultivation. The inherent fertility of virgin land would be quickly dissipated if existing farming methods were followed upon it. Therefore, to provide more land without giving attention to the system of farming to be followed would merely postpone solution of the problem. The maximum distance to "bush" land from any point in North Mamprusi is about 8 miles, and it would not appear unreasonable to expect a man to move this distance voluntarily, if an adequate food supply were his greatest consideration and the acquisition of more land would ensure it. Changing economic and social conditions are bringing about the necessity for changed methods of farming. There is little doubt that development will stimulate expansion into unpopulated areas; then will be the time to foster migration, not before.

Direct Causes.

Density of population is therefore only indirectly a cause of recurrent food shortage; some of the more direct causes are:—

1. Farming practices which are not sufficiently intensive for conditons. A system of "fixed" cropping is followed and manuring is quite inadequate.

2. The innate distaste of the people for consistent labour, especially when there is a chance that it may not be essential. That is, a farmer would rather sacrifice to his ancestors for more rain—and perhaps spend the rest of the day at market (not marketing)—than to give his farm a surface cultivation to conserve the moisture already in the ground.

3. The lack of sufficient incentive, and a conservatism which makes a man prefer to cultivate a small area of impoverished land, cultivated by his ancestors, to going eight miles, or less, and having the labour of breaking up bush land (predial larceny is often offered as an excuse when bush farms are suggested).

4. Too great a reliance upon cereal crops. A bad season for cereals, or, as in recent years, depredations by locusts, means food shortage; that the season might have been a good one for root crops or legumes, does not affect the situation very much.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

5. A "vicious circle" has been created. Years of living on the margin of subsistence, have sapped the energy of the people and predisposed them to disease; at the present time, many are physically incapable of the hard work which is necessary to bring about an improvement in their conditions.

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Suggestions for the Improvement of Local Agriculture.

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From our study of the causes of food shortage it is possible to suggest ameliorative measures. The two main forms which these measures must take are :—

1. By increasing the area of land in cultivation.

2. By improving the existing system of farming.

But as we have seen above (Indirect Causes of Food Shortage) the effectiveness of the first measure depends upon the second. It is therefore upon measures for improving the existing farming system with which we are concerned at present. Some of the more important of these are considered, in tabular form, below. It should be mentioned that the improvement in water supplies, which is shortly to receive attention (14), will play an important part in the general improvement of conditions, towards which the following suggestions are made :—

1. *Growth of a greater diversity of crops.*

   Too much reliance is placed upon cereals. The planting of more groundnuts and sweet potatoes; the introduction of pigeon peas, "sanzi" (an early maturing Dagomba bean), cassava, and, in some areas, yams and sesamum, would make useful additions to the present range of crops.

2. *The introduction of a rotation of crops.*

   This would require study over a period of years, but if, as seems desirable, the area of legumes and roots is to be increased, some form of rotation will be essential.

3. *Attention to the increase and maintenance of soil fertility.*

   Just as farmyard manure is the basis of arable farming in most other countries in the world, so might it usefully become the basis of arable farming here. "Mixed farming" provides the solution. The livestock of the country have a greater potential value as the producers of

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

000 increased crops through their manure, than they have in any other way at the present time. If instead of burning all waste vegetable matter, it was carefully conserved for livestock use, either as fodder, or as litter, it would be possible to ensure :

(i) By stall feeding as much as possible, the maximum amount of dung and urine would be dropped where it could be used, instead of on waste places.

(ii) By the supply, as bedding, of all vegetable waste which is too coarse for fodder, the manufacture of farmyard manure of high quality by trampling and accumulation under the feet of stock. Manuring would form an essential part of the crop rotation mentioned in (2) above.

4. *Greater attention to soil management.*

This is a very big subject for it implies consideration, not merely of the depth to which a man can hoe and the area he can cover in a given time, but the management of the soil as an environmental factor in crop production. Some of the improvements which could be effected locally are :—

(i) Cultivation of the soil preliminary to planting, with the production of a tilth. In this way crops would be given a better start in life than they receive at present.

(ii) The growing of crops on ridges, instead of on the flat, would be a great advantage on much of the land at present cultivated, where waterlogging at some seasons, and soil wash (contoured ridges), are serious. Furthermore, with a system of surface drains, ridging could bring many fertile valley lands at present uncultivated, into a state of high productivity.

(iii) The planting of crops in lines, instead of anyhow, would greatly facilitate the work of intercultivation, which is a race against weed growth from the month of May onwards.

(iv) The practice of measures to check soil erosion. The first and most important measure is the control of burning on grazing lands and along paths and roadsides. The unburnt material, if cut and stacked,

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

would provide the fodder and bedding required for item 3, above. Contoured ridging has already been mentioned. Rough cultivation of the soil before it dries out after harvest, together with non-burning and contoured ridging, would leave the soil in a condition to absorb the early rains instead of causing them to run off.

The introduction of simple animal drawn implements, another aspect of "mixed farming", is the obvious answer to questions of improved soil management.

5. *The extension of rice cultivation.*

Rice has very much to recommend it and although the people give as their reason for not growing more—"We don't care for it", the true explanation lies probably in the difficulty of hoeing suitable rice land with the implements available. This difficulty would no longer obtain with the introduction of suitable animal-drawn implements. Many areas in the district become water-logged in June and July and they are then unsuitable for other crops or grazing, but they will grow excellent crops of rice. Rice stores well, and is therefore a good famine reserve crop, and the straw is a valuable cattle fodder.

6. *The encouragement of thrift with surplus food.*

Under a system of Native Administration, with the curtailment of tributes to headmen and Chiefs, there is no reason why individuals should not now set aside a reserve, from one season to the next, in the knowledge that they will be free to enjoy it. Or the machinery of the Native Administration might be used to lay down communal famine reserves, as in parts of East Africa. The family section would appear to be the best unit for this purpose.

7. *The introduction of methods of animal husbandry.*

The control of disease, the castration of scrub bulls, the supply of improved bulls, and the organisation of water supplies, are matters which have received, or are receiving, the attention of Government. Attention should also be given to other classes of stock besides cattle. If these measures are to take full effect, the whole environment of

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

livestock must be improved—using the term "environment' in its widest sense. Such simple improvements as the provision of roofs for protection against rain and sun, the supply of fodder for the dry season, and bedding, are well within the capacity of the people to adopt. Other improvements, not so easy to introduce but equally desirable, are the control of mating, and the control of grazing: little advance can be made with these until grazing land is enclosed. Just as enclosure has had to be adopted in other countries as their agriculture progressed from the pastoral to the "fixed" state, so will it have to come here ultimately.

8. *Selection and distribution of improved varieties of seed.*

A vast field for improvement lies in plant breeding, but it will be non-effective until some of the other measures have received attention, and for practical purposes it can be neglected at present.

Summary. Nearly all the measures suggested above may be summed up in the words "good husbandry"; and "mixed farming" is undoubtedly the key to the situation. Marked improvement in general economic conditions is unlikely to come from concentration upon any single aspect of local agriculture, but from attention to every aspect of the industry as a whole. Having diagnosed the disease, the next step is to carry out experiments to test our ideas upon treatment, before trying to work a cure. Upon this second phase of the work—experimentation—we are engaged at the present time. Our methods of approach to the problem, and the progress we have made so far, are discussed in Part II below.

Part II.

Section I.—Experimental Work.

The detailed study of local farming methods described in Part I enabled suggestions for improvement to be made with reasonable certainty. But the form which these improvements should take and their details could be decided only after careful research. The nearest agricultural experiment station to North Mamprusi is at Tamal in Dagomba, where, as we have seen, conditions differ in practically every respect. It was obvious that very few results from Tamale would apply in the North and that experiments would have to be carried out locally.

This work was started in 1934 with a few observation plots and minor statistically planned experiments, and each year since then this side of the work has been increased. The aim has been to keep the trials as close to the farmer as possible, that is, simple trials with single issues. Small areas of land were acquired at Zuarungu, Yekeni, Sabiya, and Dagari, in Zuarungu Area, and at Navrongo, in Navrongo Area. In addition simple cultivation trials were laid-down in the farms of the Headmen of Goragu and Yekeni. The location of these places may be seen by reference to the map at the beginning. The method of experimenting in natives' farms has much to recommend it, particularly in a country where vacant land is difficult to obtain; it is possible only with such simple experiments as we have envisaged. It has a demonstration value as a link between the experiment centre and the native farm after preliminary trial, and is useful when a practice is known to be good and it is desired to find out how good.

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The general results of the experimental work will be discussed below in Section I. It is necessary to emphasise that this work is exploratory in nature; in many cases conclusions have been based upon an insufficient number of replications for complete statistical reliability. This is not to say that our results are necessarily untrustworthy, but that they should be treated critically in subsequent stages, before extension. It is useful to have a stock-taking of the information we have gained during the last three years, because we have now arrived at a stage in our experiments when it is necessary to combine the results of individual experiments and to study them together in their place in a complete farming system. All our experience has been leading up to some system of "mixed farming" as a natural corollary (1); what is recorded here is a review of the situation as an introduction to the subject. A general summary and discussion in particular relation to mixed farming is given in Section II. Section I will be discussed under the following headings:—

I. Rotation Experiments.

II. Cultivation Experiments.

III. Manurial Experiments,
  a. manufacture,
  b. utilisation.

IV. Root Crops Experiments.

V. Miscellaneous Trials.

General conclusions are discussed in the text and tables are given in the Appendix IV.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

1. Rotation Experiments.

657 Our survey suggested the desirability of increasing the area planted with root crops and legumes, to serve as famine reserves, supplementary foods for livestock, and to give the land a rest from continuous cereals. Our aim in these trials is to see how far this increase can be effected and at the same time to ensure for the farmer not a less quantity of grain than he was getting before. By the use of animal drawn implements and farmyard manure our experiments seem to show that this will be possible, but it is too early yet to draw definite conclusions.

Sabiya.

Two rotation experiments are being conducted. The first was started in 1934 at Sabiya in "bush" land. The aim was to obtain information upon the best manner in which land not previously cultivated could be exploited. A four-course rotation was followed :—

1st year.	Yams and interplanted late millet	Unmanured.
2nd year.	Early millet guinea corn cowpeas and neri	Manured with farmyard manure 2 tons per acre.
3rd year.	Early millet late millet cowpeas and neri	Unmanured.
4th year.	Early millet groundnuts	Unmanured.

Mean yields per acre are given in Appendix IV, Table I, from which it will be seen that yields so far are most unsatisfactory. This is due mainly to the ravages of pests—locusts, rats, wild-guinea fowl, birds, and white ants in yam seeds. At least we are learning some of the troubles which beset the farmer in the bush.

Navrongo.

The second rotation experiment is being carried out at Navrongo upon a piece of long farmed land acquired by Government some years ago as a possible terminus for the projected extension of the railway to the Northern Territories. The rotation here is similar to the one at Sabiya, except that sweet potatoes, cassava, and Coleus potatoes are included in the root area, and

the experiment is being run as a unit farm of 8 acres by a man and his family with 2 bullocks as a mixed farming experiment. The mean yields obtained in 1935 and 1936 are given in Appendix IV, Table 2. It is interesting to observe that in 1936 early millet and guinea corn following a previous yam crop gave nearly a 100% better yield than where they followed sweet potatoes. 654

It is too early to express any opinion upon these rotations at present.

II. *Cultivation Experiments.*

As already described in Part I (Preparation for Planting), the native practice is to plant the main crops of cereals upon the previous season's stubble without giving any preliminary cultivation. With hand cultivation alone it is not possible to cultivate a very big area during the time between the first and second rain of the year, and we know that to miss the planting rain with early millet is serious. The introduction of animal drawn implements has completely altered the situation. It is possible with a cultivator or a plough to loosen the soil over a large area before the land dries out after the previous harvest, and we have found that each year that land is ploughed makes it easier to work. The local West African Shorthorn cattle stand up quite well to work. The questions we set ourselves to answer in our experiments were: "what is the best kind of cultivation under average local conditions, *i.e.*, ridge or flat?", and "what implement, or implements, can do this most economically?".

Implements used.

So far we have experimented with the following:—

Ransomes "DY" ridging plough,

" "M.S.N." single furrow plough,

" "Punjab" " " "

" "Victory" " " "

" BTSL cultivator,

Nigerian 5 tine iron cultivator from Kano,

Nigerian pattern 3 tine cultivator made locally upon a log frame.

Ridge Cultivation v. Flat.

So far experiments suggest that under the light soil conditions here, the combination of Ransomes DY ridging plough and the Nigerian pattern wooden cultivator will prove the most economical

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

combination. Experiments over the last three years show a definite advantage in favour of ridging (see Appendix IV, Tables 3-7) as against flat cultivation; although, as might be expected, the effect upon yield varies in different places and in different seasons. Some of the advantages in favour of ridging are:—

1. Planting in straight lines is simplified and subsequent inter-cultivation is made more easy.

2. Contoured ridging is particularly useful as a measure to check soil erosion.

3. Cultivation can be extended to fertile valley lands too wet to grow crops on the flat.

4. Manure is concentrated in the middle of the ridge where feeding roots can make most use of it.

It has been found that with a DY plough an acre or more can be ridged in a day by a pair of bullocks working in the morning and in the evening. Excellent ridges are being made in Tamale by the Officer-in-Charge using the single furrow "Victory" plough, but since this involves going over the land twice we may find here in the Northern Province, with precarious early rains and a large area of early millet to plant, that the more quickly made, though possibly less efficient, ridges of the DY plough will suit us better. This matter will receive attention in the future.

III. *Manuring.*

a. *Manufacture of Manure.*

In the improvement of local agriculture attention to cultivation and manuring must be given together, for the one cannot take full effect without the other. The effects of quite small dressings (2 to 5 tons per acre) of native compost upon crop yields (see Appendix II, Tables 6 and 7) leave no doubt as to the order of improvement which we may expect from attention to this subject. The amazing growth of crops in the immediate vicinity of compounds tells its own story. But as we have seen, only 12% of the total area of land cultivated upon native farms receives a dressing of manure, and this is quite inadequate to maintain fertility under a system of continuous cultivation. We set ourselves to find out, therefore, how, with a reasonable head of stock, we could make manure in the biggest quantity and of the best quality. 'Green' manuring could not be considered locally for obvious reasons; some form of compost or pen manure was envisaged, or a combination of the two.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Compost.

Since the native manure is a compost, inefficiently prepared from vegetable waste and the sweepings of animal manure from the compounds, we turned our attention first to the manufacture of compost on the lines advocated by Sir Albert Howard at Indore (15). A battery of pits was laid down at Zuarungu in 1935 and "Indore" compost of excellent quality was prepared. (For analysis see Appendix IV, Table 8). But as Sir Frank Stockdale pointed out during his visit to Zuarungu in 1935, the process was far too complicated for the local native to adopt at present; and the shortage of water in the dry season would make it impracticable during half the year. The experience we gained of the decomposition of organic matter was valuable however. The method has now been discarded in favour of the manufacture of farmyard manure.

Farmyard Manure.

By farmyard manure is understood the material which results from the decomposition of cellulosic wastes—mainly cereal stalks and grasses—supplied as bedding to livestock; it receives the dung and urine from the stock and is trampled and allowed to accumulate under foot. Farmyard manure forms the basis of most systems of arable farming in the world; it has been adopted in Nigeria (3), Tanganyika (16), and elsewhere, in mixed farming; and we have adopted it here with most satisfactory results. It has been found that a pair of bullocks will produce about 5 tons of manure of good quality in a year, and a donkey, just over two tons.

The stock are housed in a pen, part of which is open, and part covered. The manure is allowed to accumulate in the covered part where clean grass bedding is added every morning. In the open part resistant material, like guinea corn stalks, is trampled and soaked with rain in the wet season; as it gets broken up it is thrown into the covered part together with any dung dropped outside. The junction of the walls and floor of the pen is rounded, and the floor is made saucer-shaped to reduce air pockets. Very little fly breeding has been found to take place and, if sufficient bedding is supplied, the pen keeps "sweet" and clean. So far only working bullocks and a donkey have been kept in this way. It has been suggested that the method may not be satisfactory with smaller stock and calves.

Human Health.

From the standpoint of human health we have convinced the local Health Authorities that so far from being insanitary, our method of manufacturing farmyard manure actually represents an

654 advance in domestic sanitation over the present native practice. We are agreed, however, that it is desirable to keep stock separated from the peoples' living quarters; that a roof is essential in the rainy season; and that clean bedding must be put down regularly and in adequate quantities. (It will be remembered, see page 33, that the present native practice is to keep livestock at night within the compound with no litter, upon an unbeaten floor, which is only irregularly cleaned out, and there is no roof protection; this dirty yard has to be crossed in passing from the entrance of the compound, to the living quarters.)

b. *Utilisation of Manure.*

Manurial experiments have been carried out at Zuarungu and Navrongo since 1934 using small dressings, 2 tons or 4 tons, of farmyard manure, "Indore" compost, and native compost. (The manure used in the 1934 experiments was leached cattle dung of doubtful value.) Mean yields obtained in these experiments are given in Appendix IV, Tables 9 to 13. It will be seen that these small dressings of manure resulted in yield increases of up to 80% over the yields from controls, unmanured. It should be noted, however, that nearly all our yields compare very unfavourably with yields upon native farms. The reason for this is that our experiment centres, in every case, are situated upon land completely out of condition. Nevertheless our results are valid within the limitations of the trials.

Residual Values.

Residual manurial trials at Navrongo showed statistically significant values remaining after the application of 2 tons and 4 tons of dung to sweet potatoes, coleus potatoes, and mixed cereals, in 1934, upon subsequent cereal crops in 1935 and 1936. The residual effect of manure in these trials in 1936 was more marked upon the vegetative growth early in the season, than was reflected in the yields.

Optimum Dressing.

Our experiments so far suggest that the optimum dressing of manure under local conditions is probably from 2 to 4 tons per acre, and that such a dressing is desirable at least once in four years. It should be mentioned here that this is the optimum under present conditions; with an increase in livestock, and the introduction of stall feeding, the amount of manure available will be increased and heavier dressings may be practicable. So far we

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

have refrained from experimenting with anything outside the capacity of the better farmers in the district to adopt; it would be of little value to us to know, for instance, that ten tons of manure per acre are desirable, when the maximum amount available is say three or four tons. And if these small dressings were not satisfactory we should have to consider other measures for maintaining fertility. 654

IV. *Root Crops.*

The desirability of increasing the proportion of land planted with root crops has already been stated. Experiments have been conducted with the following crops: yams (Dioscorea spp.), sweet potatoes (Ipomoea batatas), cassava (Manihot utilissima), and Coleus potatoes (Coleus dysentericus). The conclusions reached with regard to each are discussed below.

Yams.

Yams are the staple crop of the Mamprusis and Dagombas further South, and except for one or two special areas near the Volta Rivers—South Kusasi and South East Zuarungu—where conditions resemble those in Mamprusi, they are practically not grown at all in North Mamprusi. Yams are imported, however, and sell for very good prices in local markets. Ill considered attempts to introduce yams in the past had not met with much success (a notable exception being Chana, in Navrongo Area), and it was considered desirable to explore the situation by experiment. [244]

Our experiments have taken the form of variety trials and two Dagomba varieties, Kuki and Puno, have proved outstandingly the best yielders in every trial, see Appendix IV, Tables 14 and 15. But even the best yield from these does not compare with an indifferent yield in Dagomba. Nevertheless, a low yield of saleable tubers might prove profitable for sale locally as a luxury crop. In a season when rains come early and keep on late, yams yield fairly well; but since the early and the late rains are notoriously variable in North Mamprusi, yams must always be regarded as a gamble and only small scale planting is recommended. A point in favour of yams, which was brought out in the Unit Holding Rotation Experiment at Navrongo in 1936, is the remarkably high residual value of the heavy yam cultivation by comparison with the cultivation for sweet potatoes; this was shown by the yields of a subsequent mixed cereal crop. (The difference was nearly 100%.) A small area of yams would appear to be worth including in unit holding trials.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Sweet Potatoes.

654 Three local varieties of sweet potatoes have been tested at Zuarungu and Navrongo—NANURI-SUNGA, NANURI-PUNGA, and NANURI-YADAGA. Of these, the last two have proved the easiest to establish and the most consistent yielders. The first has therefore been discarded. Results of these trials are given in Appendix IV, Table 16. Our yields so far have not been very satisfactory (between 2 and 3 tons per acre of tubers), but the reason for this has been due largely to the difficulty of obtaining sufficient planting material. There can be no doubt as to the value of this crop in a system of mixed farming locally. The tubers and tops provide very palatable fodder for livestock in the early part of the dry season when grazing becomes of poor value. The importance of the crop as a famine reserve for the people in years of locust invasions requires no stressing. Our practice is to plough up a ridge of sweet potatoes a day, as required for feeding. The tubers keep quite well in the ground until the end of February. Sun-dried, sliced tubers were found to keep very well for the whole of the dry season. There is undoubtedly a big future for this crop, and we are including a large proportion of it in the root area on unit holdings.

Cassava.

We have not very much information upon this crop in North Mamprusi. Observation plots at Zuarungu and Navrongo were planted in May and June, 1935, and yielded at the rate of from 2 to 6 tons of tubers per acre in February and March of 1937, having occupied the ground for about twenty months. Cassava is of particular value upon the mixed farm as a succulent food for livestock during the period from mid-February, when sweet potatoes start to rot in the ground, until the fresh grass is ready for grazing in mid-April. And as a famine reserve crop it is *renowned the world over. But whilst cassava is obviously* a desirable crop to grow, it is quite impracticable upon native farms at present because of damage by livestock, principally goats, during the dry season. Under different conditions, *i.e.*, with enclosure, or attention to the control of livestock, cassava could come into its own. The difficulty might be solved if everybody planted it; for individuals to do so without fencing would be a waste of time.

Coleus Potatoes.

This small tuber is of no great importance, but a small quantity is included in Unit Holding experiments since the people normally devote a small area to it. Coleus potatoes do not store well and yield between 1 ton and 1½ tons of tubers per acre under favourable conditions. As a stock food they cannot compare in value with sweet potatoes or cassava.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

V. *Miscellaneous Trials.*

Under this heading experiments with groundnuts and rice will be discussed and observation plots of Sesamum indicum, "acha" grass (Digitaria exilis), Bengal beans (Mucuna spp.), Dolichos lab-lab, Dolichos biflorus, Calopogonium mucunoides.

Groundnuts.

Groundnuts are next to cereals in importance in North Mamprusi. They grow very well upon the sand drifts and their value as a potential export crop, as well as an important stock food, gives them a high place in cropping on a mixed farm. Experiments have been confined to testing the merits of selections from "bunch" type Nigerian groundnuts, imported for the groundnut scheme at Ejura in 1933, against the local procumbent variety. In three years of trial the Nigerian variety has proved itself to yield rather better than local and its habit of growth enabled a saving in labour at harvest of 30% to be effected—an important consideration upon a mixed farm. Mean yields obtained in these trials are given in Appendix IV, Table 17.

Rice.

Trials over three years proves conclusively the value of rice locally. It yields a bigger weight of food for man and for beast from a given area, than any crop we have tried so far. Variety yield trials have been carried out to test Local rice, Tamale selections—black husk, and yellow, and Essiama selections, NZ2 and NZ4. Of these, Tamale Yellow has proved itself to be the best; in 1936 it yielded nearly 1,500 lbs. of paddy to the acre and 5,900 lbs. of straw. The working bullocks eat the straw very readily during the dry season. Mean yields from rice trials are given in Appendix IV, Table 18.

Sesamum Indicum.

Odd plants of this crop are occasionally found in North Mamprusi, and following a visit of Dr. W. E. McCulloch, Dietetics Research Officer, Nigeria, in 1931 (17), great hopes were entertained from its extension. Trials have not given satisfactory results however. The plants were severely attacked by caterpillars and growth was not uniform. Planting in the third week of May upon ridges 3' apart was found to be most satisfactory. Early thinning was found to be essential. Trials have now been discontinued in favour of other crops.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654 *"Acha" Grass (Digitaria exilis).*

Observation plots of this small grain plant have been found easy to establish. Yields of up to 470 lbs. of grain per acre have been obtained and 22 cwts. of hay. It is considered however that time and space can be more profitably devoted to other crops, and trials have not been continued. Acha grass has a possible value as a trap crop for the parasite Striga, sometimes a serious pest locally on guinea corn.

Pigeon Peas (Cajanus cajan).

Pigeon peas are not grown locally. Observation plots show that in a long rainy season the crop will grow quite well, but, since it ripens in the dry season, it suffers from damage from livestock in the same way as cassava. Trials are being made with early maturing strains from Pusa, India.

Green Manure and Fodder Crops.

Observation plots of Bengal bean (Mucuna spp.), Dolichos biflorus, Dolichos lab-lab, and Calopogonium mucunoides, have been planted at Zuarungu and Navrongo, and of these, Bengal beans have proved to be outstandingly the best. But all ideas of green manuring have now been given up in favour of farmyard manure; Bengal beans have a value, however, as a fodder crop and small areas are grown for this purpose.

Gum Arabic.

Hopes were entertained at one time of finding in the gum from Acacia Senegal an export crop from North Mamprusi. The tree is found in large numbers in a belt running through the district. Repeated tappings produced very poor results and it is considered that the "harmattan" is not sufficiently severe to cause the tree to respond. Trials have been discontinued.

Section II.—Discussion of Findings in Particular Relation to "Mixed Farming".

In West Africa the term "mixed farming" is used to describe a system of agriculture in which livestock and land are complementary (1). With a pair of bullocks and a plough, from 8 to 12 acres of land can be cultivated instead of the usual 2 to 4 acres by hand methods; and by the use of the farmyard manure made by the working bullocks and other stock a farmer might have, this area of land can be maintained at a reasonable level of fertility, and the wasteful practice of "shifting cultivation" can be eliminated. Depending upon circumstances, the extensive use of the plough is important and a high yield per man farming is the

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

aim; or alternatively, the intensive use of manure is important and a high yield per acre is the aim. Observations made during a visit to Nigeria in 1936 to study mixed farming are recorded in Bulletin No. 33 of the Department (3). We are starting to-day where Nigeria started ten years ago and Nigerian experience is valuable to us here as a guide. The best mixed farming system for North Mamprusi, however, must be worked out to suit our particular conditions. These conditions are discussed below. 654

Intensive System Required.

That conditions are ripe for the introduction of mixed farming has already been shown. The cultivators of the soil own livestock and practice a system of fixed cultivation relying, in part, upon regular manuring to maintain the level of crop production. But the system is not nearly so intensive as conditions demand. It is therefore the intensive use of manure with a high yield per acre which is important here.

Animal drawn implements, though necessary to enable the manure to take full effect, come second. In passing, it may be mentioned that herein lies the main difference between a system for North Mamprusi and one for South Mamprusi and Dagomba. In the South, where land is abundant, the extensive use of the plough will be important, with possibly a combination of green manuring and farmyard manure. North Mamprusi resembles the Kano "suburban areas" in Nigeria.

Conservation of Organic Matter.

"Non-burning".

The first step, which it is within the power of every farmer to adopt without the expenditure of capital, is to conserve all the waste vegetable products from the farm and from waste land (grazing areas, roadsides, fallow) for use as fodder, or if too coarse, as litter, for livestock. This implies control of the wasteful practice of burning. A good start was made in Zuarungu Area in 1936-37 season through the Native Administration; during this period practically no wide scale burning took place. This measure alone is likely to have far reaching effects for the welfare of the district, quite apart from its essential relationship with mixed farming. These effects will be cumulative and will not be appreciable in a single year; some of the more important advantages which may be expected are:—

1. Organic matter, in which local soils are particularly deficient, will be conserved for use as the basis of farmyard manure.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654 2. Livestock fodder can be obtained for the dry season by cutting grass for hay before the onset of harmattan, and by the conservation of cereal and legume leaves.

3. Grazing lands will be improved, both in the stock carrying capacity and in the length of the grazing period.

4. Soil erosion will be considerably reduced (and less damage to roads). Control of vegetation must always be the first anti-erosion measure.

5. Tree growth will be assisted, both timber—notably deficient—and fruit. (Figures from Yendi Shea Reserve, in Dagomba, show this.)

6. Tree population will increase due to more successful regeneration.

7. Water-table of district will have a higher average height throughout the year, due to a slower rate of percolation, less run-off, and decreased evaporation.

8. Less danger from shortage of roofing grass. (This is likely to become increasingly important as flat roofs must give way to thatch, due, in part, to a growing shortage of strong timbers.) It might also be mentioned that there is a small market for grass, used as fuel in the producer gas engine, at Nangodi Mine.

Against "non-burning" very little can be said in North Mamprusi, In a few swamp areas burning might be desirable to check the development of acid conditions, and on the edges of bush land, as around Pwalagu on the Volta River, tall grass—tall because there is not sufficient population to cut all that is available—might encourage lions to come unpleasantly close to the houses. The control of cattle ticks has been suggested, but regular "dipping" is the remedy for these. Care must be taken to see that grass in waste places and on grazing lands is cut before the middle of December, for a late burn is more serious than the usual burn in November and December, and the risk will be ever present. It must be stressed here that it is not sufficient merely "not to burn"; if the grass cannot be kept close by grazing, coarse, dead grass must be cut down during the dry season, to enable the fresh grass to come through at the beginning of the following rains. (This is one of the reasons why "non-burning" is applicable at present only to areas where the system of cultivation is "fixed" and grass and grass-land is scarce and valuable because the proportion of arable to grass is high. In South Mamprusi and Dagomba, "shifting" cultivation is the practice and the proportion of arable

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

to grass ("bush") is infinitesimal; the comparatively small population cannot possibly use all the grass available, and cannot, and need not, try to prevent burning; although they can ensure an early burn in many places with advantage. The difference between the two sets of conditions has been frequently ignored in discussions on the subject in the Northern Territories.) It is interesting to observe that burning of the veld is condemned in South Africa and parts of East Africa, and controlled by strict legislation. 654

Manufacture of Manure.

If the material conserved in the way described above is supplied as bedding to livestock, manure of excellent quality can be made by the method explained on page 45. It is desirable to feed stock on the farm as much as possible so that the loss of the dung and urine is reduced to a minimum. At least three times as much manure can be made in this way with a given head of stock than the native makes at present; and furthermore, farmyard manure is richer in plant food than native compost (see Appendix IV, Table 8). The output of manure from a mixed farm with an average stocking of say 2 working bullocks, 1 cow and calf, 1 donkey, 3 sheep and 6 goats (c.f. average stocking per compound, text Table 5, page 32) would be at least 8 tons per annum. Yields from native farms, see text Table 4, page 30, and from our experiments, page 46, show an average crop yield increase of up to 80% from the use of such small dressings of manure as 2 to 4 tons per acre; and residual trials show a value remaining in the third season after application. The average area of land farmed by a compound is nearly 8 acres; thus, with the stocking we have assumed, about 25% of the whole farm could be dressed with manure at the rate of 4 tons per acre in each year, instead of a smaller average dressing upon 12% of the area.

It will be seen that by the extension of this aspect of mixed farming alone—the means for which already exist and involve no more than the time of the farmer, of which he has an abundance, and the trouble of collecting and utilising the waste materials already everywhere in the district—much can be done towards ensuring an adequate food supply for the people, and better conditions for their livestock.

Animal Cultivation.

But whilst to increase soil fertility by the use of manure is a big step forward, not to improve methods of cultivation at the same time would be to lose much of the potential value of that fertility; manuring and cultivation must go hand in hand. Animal cultivation provides the solution. Admittedly more than half the farms

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654 in North Mamprusi are too small in area, too irregular in shape, too stony, or too hilly, to allow of economic animal cultivation, but there is also a large number of farms—more than we can hope to affect for many years to come—which are suitable, and it is upon these that we must concentrate. With expansion in the future, it is probable that land will be specially selected because of its suitability for animal cultivation, but this time is sufficiently far ahead not to concern us at the moment, although it would be well to keep it in mind. Local West African Shorthorn bullocks have been found to be easy to train and to handle, and to be sufficiently heavy for ploughing the light soils of the district; although an increase in size would be helpful. Experiments have shown that the type of cultivation best suited to our conditions is to plant crops on ridges, and that by using a light scuffling and ridging plough, and a simple cultivator, one man and a boy, with his wife to assist in planting, can farm an 8 acre holding with the work of two bullocks. Not only is this area three times the size of the area a man cultivates by hand at present (see page 18) but the cultivation is more efficiently performed. These factors, taken into consideration with manuring, already discussed, give some idea of the scope of the improvement at which we are aiming.

Economics of the Plough.

What we have yet to prove, however, is that within a reasonable period, say four years, a farmer will receive a return from the use of bullocks and bullock drawn implements to cover the original cost of the implements, and to provide reasonable interest on the extra farming capital invested, and for his enterprise. Unless we can prove conclusively that mixed farming is profitable no amount of demonstration can extend the use of the plough upon any great scale; neither can we put up a case to Government or the Native Authority for loans to supply the initial farming capital. The proof lies in the actual returns obtained from experimental unit holdings. The free distribution of implements to Chiefs and Headmen will not demonstrate the economic value of these implements; we know that a plough can work locally, but can it work profitably? Let us examine the matter more closely.

Export Essential.

Since the plough is an imported article it follows that for every one which comes into the country, something of an equivalent value must go out, directly or indirectly. It has been shown that the high cost of road transport rules out the possibility of an export crop for an overseas market (1 and 18). It is in this respect that we are at such a disadvantage by comparison with Northern Nigeria, where cheap rail transport enables cotton and groundnuts

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

to be profitably exported from distances more than 600 miles from the coast. The alternative is a local export to some part of the country with money to spend; the obvious solution lies in the export of livestock to Ashanti and the Colony.

Livestock Industry.

The conditions under which livestock are kept in North Mamprusi have been fully discussed under the heading "Animal Husbandry", pages 31 to 33. It has been shown that whilst livestock are used mainly for uneconomic purposes, marriage dowries and sacrifice, they are becoming increasingly regarded as a source of money; and with the rapid development in money consciousness which is proceeding to-day, there is no doubt that the value of livestock will become to be recognised more and more. Survey showed that 54% of compounds (probably rather less over the whole district) owned cattle of the West African Shorthorn type. Bullocks find a ready sale to butchers' agents at prices varying from £1 10s. to £3 15s.; and milk, in the form of curds, is sold in local markets. Nearly all compounds own sheep, goats, fowls, and guinea fowls, and the trade in fowls is already very well established. The market for livestock in Ashanti and the Colony is practically unlimited; only a very small proportion of the meat slaughtered is locally grown. But if this proportion is to be increased, local methods of animal husbandry must be improved. Attention to breeding alone is not enough, as the Director of Veterinary Services pointed out in his Annual Report for 1935-36 (12). And because the bulk of the livestock in the Gold Coast belong to the cultivators of the soil, it will be seen, that the development of mixed farming is just as necessary for the future of the livestock industry, as the development of the livestock industry is for the future of mixed farming. Thus the ultimate justification for the investment of capital in working bullocks and cattle-drawn implements must be in the export of livestock. Work with livestock is necessarily slow, but if good feeding and good breeding produce an improvement in the local stock equivalent to the improvement effected in Northern Nigeria, by attention to these matters with Zebu cattle (13)—and there would seem to be no reason why it should not—we shall have little difficulty in justifying the cost of a plough, when local unimproved bullocks are worth nearly £4 a head to butchers' agents at the present time.

Sale of Surplus Foodstuffs.

But before livestock receive better treatment the people themselves must have sufficient food, and it is by the sale, as food upon local markets, of a surplus of production over individual requirements that the first mixed farmers are likely to receive a return. At the present time, large quantities of grain are imported from

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11
Kusasi

439 Dagomba, Mamprusi, and Kusasi, during the dry season, and much of this is stored at such places as Bolgatanga, and sold during the time of greatest shortage, that is before early millet
439 is reaped at the end of June. A sack of corn weighs approximately 180 lbs. and sells at from 14s. to 18s. a sack. This trade enables
435 us to give a money value to the produce from our farms. It is interesting to examine the yields from the cultivation experiment in the Headman of Goragu's compound farm (see Appendix IV, Table 3). From this it will be seen that during a three-year period the total mean yield of grain per acre from "native" plots was 2,370 lbs., and from "ridged" plots (cultivation by hand in 1934 and 1935 and by plough in 1936), 4,384 lbs.; a mean increase per acre for three years of 2,014 lbs. If this increase had been sold in Bolgatanga market at 13s. for 180 lbs. (*i.e.*, 14s. less 1s. for the bag) it would have realised nearly £7 10s. It would not require many acres yielding at this rate to justify the expenditure of £4 upon implements and £6-£8 upon working bullocks, that is assuming the farmer had no bullocks of his own already. Furthermore, very much less labour was expended upon the "ridged" plots than "native". Admittedly other cultivation experiments have not given such spectacular results, but the indication is the same in all.

000 It is difficult to say how much grain it would take to saturate the local market, but by the time it becomes saturated the Department of Agriculture should have acquired sufficient information to advise farmers how a surplus can most profitably be fed to livestock. For this reason an experimental stock farm is an essential part of the machinery for mixed farming research. In passing it might be mentioned that foodstuff prices will fall, as saturation point is approached: whilst this will not be popular with fixed farmers, it will assist the poor man to get food more easily. In this way we shall be accomplishing one of our primary objects in working in North Mamprusi; for it is the poor man who creates the food shortage problem, not the would-be mixed farmer.

Kusasi Groundnut Trade.

439 A consideration of sources of farming capital would not be complete without reference to a newly developed trade in de-
435 corticated groundnuts and groundnut oil from Kusasi, for the Kumasi market. From a start of 200 bags in 1933 the export has developed to 9,000 bags in 1937 (weight per bag approximately 160 lbs.). The trade is almost entirely in the hands of Messrs. Chedid, who centralise the nuts in Bawku and send them on their lorries to Kumasi when the supply of sheep and goats will not give them a full load. The lorries come North with cola, salt, cloths, etc. The price paid to the producer for decorticated groundnuts is 8s.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11
Kusasi

to 8s. 6d. a bag (about £4 18s. per ton); and the cost of transport on a bag to Kumasi, a distance of 380 miles, is from 4s. to 5s., which works out at about 2d. per ton mile. The trade is of particular interest in that it shows the people in Kusasi are prepared to grow a crop to sell for cash, and that transport will follow production, even at so great a distance from the market.

CONCLUSIONS.

The time is ripe for the introduction of mixed farming. That is to utilise livestock, firstly, to provide an adequate food supply for the people; and secondly, to produce a surplus for sale, either directly, as in the case of groundnuts in Kusasi, or metabolized and sold in the form of livestock, for which we have seen there is a large market in the South. In cases where labour has to be hired for farm work, as upon school farms, and possibly upon the farms of salaried Chiefs, when tribute and tribute labour is commuted, mixed farming can be recommended immediately as a profitable investment. It is possible that the production of such money crops as groundnuts, cotton, ginger, and sesamum, which are not profitable to grow by hand methods of cultivation for an external market, might become profitable with animal cultivation.

The control of burning and the use of the material so protected, as dry season fodder or bedding for livestock and the manufacture of farmyard manure, is within the power of everyone to adopt with advantage. But animal cultivation has a limited application in North Mamprusi for two main reasons:—

1. Lack of farming capital. Some form of loan scheme similar to the one in Nigeria will have to be devised to overcome this difficulty. We must first prove that it will be possible for a farmer to repay his loan before we can prepare details.

2. Density of population, and the shortage of land. The average area of land cultivated by a man at present is 2½ acres but the average area farmed by a compound is 8 acres. The compound must therefore be the unit owning a plough and bullocks. The time so saved can be devoted to the rearing of livestock, making enclosures round farms and grazing lands, and so on.

It is probable that, ultimately, expansion will take place into areas at present unoccupied. This must be attended with careful control.

The limiting factor for the rapid extension of mixed farming is likely to be the people themselves. But at least we must prove and demonstrate our system before we can say that the people will not follow. Chiefs and Headmen must lead the way. The best means of extending our results is through the machinery of the Native Administration, a section of which will have to be adapted and organised for the purpose. It is considered that the extension of proved agricultural results is as much a political problem, if not more so, than an agricultural problem.

Much careful research work requires to be done before a system suitable for general adoption can be recommended. But we have sufficient information to proceed quietly with extension work in the case of school farms, Chiefs, etc. Undue haste at the present time might seriously jeopardize future chances of success. That there will be difficulties in the future is certain; it would be well to bear in mind, however, that it is only the good farmers we can help, farmers above the average; and the number we can effect in the early stages will be very small.

Most of the requirements for mixed farming already exist in the district; organisation and farming capital are lacking. That the local farmers already own cattle and practice fixed cultivation and regular manuring, are points in our favour by comparison with Nigeria where very few peasant cultivators owned cattle. There will be no return to the tedious hoe system of farming once the advantages of the new system have been appreciated. The introduction of mixed farming offers undoubtedly the best basis for the introduction of all other measures designed for the welfare of the natives in North Mamprusi.

School Farms.

A start with demonstration has been made in 1937 by establishing mixed farming units attached to the Native Administration Schools at Sandema and Bawku. These farms consist of 8 acre units run by two paid labourers using a pair of bullocks, a plough, and a locally made cultivator. The boys assist with planting, and light operations such as thinning. The purpose of school farm is a dual one: they are intended, firstly, to produce food as economically as possible to reduce the schools' messing expenses; and secondly, as ocular demonstrations of improved methods of farming for the pupils. Many of the boys at these schools will become chiefs of the district: for them to see and assist with our methods of farming through a number of consecutive seasons, makes the time we devote to school farms a valuable investment; the dividends we shall reap in future extension work. The size of

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

these farms is limited at present by the amount of manure available; it is hoped in the future to increase the stocking by the addition of a cow, or cows. 654

N.A. Demonstration Farms.

In addition to the school farms, we are starting two demonstration farms in 1937. One is at Bongo, ten miles North of Zuarungu, the other, at Garu, South of Bawku; both are being paid for entirely by the Native Authority. At Bongo, in the centre of a thickly populated area, we are demonstrating the intensive use of manure upon a six acre holding, with food crops, and later, fowls, as saleable produce. At Garu the farm is eight acres in area, with room for expansion; groundnuts, and later, cattle, are intended to be the saleable produce here. The dry season feeding of stock and the manufacture of farmyard manure are the features most stressed at present. A point in connection with these mixed holdings which is sometimes forgotten is that it takes at least three years to get one working as a self-contained unit, that is, the fodder and bedding which is grown in 1937, is used in 1938, and forms the basis of the manure for the 1939 season. We are coming up against a number of practical difficulties in the first year, the chief of these being: inexperienced staff and labour, newly trained cattle, stumps and outcrops of stones in the farms. Very late rains in 1937 season have not been in our favour.

We have made a start and before going any further it behoves us to consolidate this start during the next two seasons. It is unlikely that we have found the best system for local conditions from the beginning, and we shall learn much from the experience of the next two years. 000

Training of Staff.

There is an immediate need for a small experimental stock farm, and for facilities for instructing the staff in some of the principles of animal husbandry if mixed farming is to make steady progress. The curriculum of the farm school run by the Nigerian Agricultural Department at Samaru, near Zaria, would be a valuable guide to what is required in this respect.

Summary.

1. A brief description of the climate, vegetation, soil, population, and economic and social conditions in North Mamprusi, is given in Section I of Part 1, as an introduction to the study of local agriculture.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

000 2. In Section II of Part I, the methods and results of agricultural surveys, 1932-36, are recorded. The salient points arising out of these are: That the primitive system of "fixed" cultivat. n is not so intensive as conditions demand. Inadequate manuring, too great a reliance upon cereal crops and a natural improvidence, result in shortage of cultivated foods in about two or three years in five. Insufficient food at certain seasons, predisposes the people to disease, and reduces their energy; thus setting-up a "vicious circle". The average area of land cultivated by a man is 2.49 acres and per unit of population, .66 acres. The average area farmed by a compound is 7.88 acres. Crop yields vary considerably from year to year. Small quantities of manure result in very great increases in yield. 54% of compounds own cattle and other livestock. 4% had no livestock.

3. Section III, Part I, gives a discussion of findings in particular relation to local food supplies and contains suggestion for improvements. It is shown that wild sources of food play a big part in preventing starvation in years of poor crops. Some compounds never suffer from shortage; these are bigger than the average and own more livestock. The growing of a bigger diversity of crops, notably root crops, legumes, and rice; greater attention to soil management; the protection of vegetation from fire and its use as dry season fodder and litter for livestock, with the consequent manufacture of manure, are suggested as improvements within the capacity of the people to adopt. These improvements may be summarized in the term "mixed farming".

4. Part II contains a discussion of our observations and experiments up to the end of 1936, as an introduction to the study of mixed farming. Experiments are discussed under the headings—rotations, cultivation, manuring, root crops, and miscellaneous trials.

5. Section II, Part II, gives a summary of experimental results in relation to mixed farming. It is shown that an intensive system is required having, at first, the sale of surplus food as its aim, but later, as the local market becomes saturated, livestock appear to offer the only possible export crop; surplus crops must be metabolized and sent to the Ashanti and Colony markets on the hoof. The manufacture and use of manure is an aspect of mixed farming which could be adopted immediately with advantage. The cost of animal drawn implements, except where hired labour would otherwise be employed as for instance on school farms, has yet to be justified by experiment. There are indications that this will be possible.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

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7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

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APPENDICES.

APPENDIX I.—Mean monthly rainfall at Zuarungu, Navrongo and Bawku.

APPENDIX II.—Details of North Mamprusi Survey. (8 tables.)

APPENDIX III.—List of crops more commonly grown in North Mamprusi with local native names.

APPENDIX IV.—Mean yields from experiments. (18 tables.)

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX I.

132 **Mean monthly rainfall recorded at Zuarungu, Navrongo and Bawku.**

Month	Zuarungu (19 years)	Navrongo (11 years	Bawku (10 years)
January	.06	nil	nil
February	.66*	.39**	.29
March	.72	.34	1.02
April	2.78	3.15	2.16
May	4.27	5.14	3.10
June	6.43	6.68	5.80
July	7.22	8.04	7.56
August	9.93	11.85	8.90
September	8.73	8.85	8.71
October	2.42	2.85	2.85
November	.68	.37	.70
December	.02	nil	.11
Means	43.92	47.83	41.20

*8.93" recorded in 1919. **3.12" in February, 1932.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II.

DETAILS OF NORTH MAMPRUSI SURVEY.

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Table 1.—Details of areas farmed (in acres) men farming and persons supported for 29 compounds recorded at 5 centres in Zuarungu Area in 1932.

Table 2.—Details of areas farmed (in acres), men farming and persons supported upon 20 recorded compounds at four centres in the Navrongo Area. Surveyed 1934 and 1935.

Table 3.—Details of areas, men farming, and persons supported at Zebilla. Surveyed 1936.

Table 4.—Summary of Tables 1-3 giving totals and means for 54 compounds surveyed at ten centres in North Mamprusi.

Table 5.—Summary of Cropping at 10 Centres of Record in North Mamprusi.

Table 6.—Analysis of Yield Data in North Mamprusi, 1932-1936.

Table 7.—Analysis of yield data for the more important crops grown in North Mamprusi showing yield per crop irrespective of mixture.

Table 8.—Giving an analysis of the livestock owned by 54 compounds at 10 centres in North Mamprusi.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 1.

ZUARUNGU AREA.

241
311
162

Details of areas farmed (in acres), men farming and persons supported for 29 compounds recorded at 5 centres in Zuarungu Area in 1932.

(Note.—The area of land occupied by buildings and waste land is not included.)

Compound No. and Name of Owner	Area farmed				No. men farming	Area per man	No. persons supported	Area per person
	Compound Farm	Separate "not bush"	Bush Farm	Total				
Bonga—								
I. Ayanbiri...	.53	2.00 1.65 .37 .14 .47	–	* 5.16	1	5.16	10	.51
II. Akani ...	2.89	.67 2.00 .42	– –	* 5.98	1	5.98	4	1.49
III. Inyaba ...	1.04	1.89	–	2.93	2	1.46	5	.58
IV. Aganda ...	6.71	.57	–	7.28	7	1.04	20	.36
V. Akawiboku	1.32	.54	–	1.86	3	**.62	8	.23
VI. Afuki ...	2.98	1.00 .50 1.45 2.03	–	7.96	4	1.99	13	.61
Totals ...	15.47	15.70	–	31.17	18	–	60	–
Means ...	2.58	2.61	–	5.19	3	1.73	10	.51
Nangodi—								
I. Doliba ...	1.62	1.57 .09	–	3.28	3	1.09	7	.47
II. Tobiga ...	13.25	.09	2.67	16.01	5	3.20	36	.44
III. Bugari ...	5.27	–	2.62	7.89	4	1.97	15	.51
IV. Banitami	3.54	–	2.36	5.90	2	2.95	7	.84
V. Babila ...	3.88	–	3.04	6.92	6	1.15	19	.36
Totals ...	27.56	1.75	10.69	40.00	20	–	84	–
Means ...	5.51	.35	2.14	8.00	4	2.00	16.8	.48

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 1 (continued).

241
311
162

Compound No. and Name of Owner	Area farmed				No. men farming	Area per man	No. persons supported	Area per person
	Compound Farm	Separate "not bush"	Bush Farm	Total				
Sambrugo—								
I. Kasalaga	5.59	.99 .90 .26 .45	–	8.19	8	1.02	15	.61
II. Alori ...	2.78	.65 .20 .32 1.00 .51	–	5.46	5	1.09	13	.42
III. Asoro ...	5.50	1.07 .53 .68	–	7.78	3	2.59	11	.73
IV. Ayarina	8.57	.34	–	***8.91	2	4.45	7	1.27
V. Kolgo ...	4.01	1.34	–	5.35	2	2.67	6	.89
Totals ...	26.45	9.24	–	35.69	20	–	52	–
Means ...	5.29	1.85	–	7.14	4	1.78	10.4	.65
Tongo—								
I. Yembila ...	2.48	2.74	–	5.22	1	5.22	4	1.30
II. Zukori ...	3.82	.45 .59	5.96 4.83 5.65	21.30	7	3.04	36	.59
III. Omara ...	1.68	.61 .65	5.25	8.19	6	1.36	23	.35
IV. Dagbana...	6.43	.46 .51 .68	–	8.08	3	2.69	13	.62
V. Goloma ...	5.98	2.50	–	8.48	6	1.41	19	.44
Totals ...	20.39	9.19	21.69	51.27	23	–	95	–
Means ...	4.08	1.84	4.34	10.25	4.6	2.23	19	.54
Zuarungu—								
I. Adachama	9.25	3.89 .86	–	14.00	4	3.5	23	.60
II. Abagna ...	5.61	–	–	5.61	2	2.8	10	.56
III. Azogadugu	2.37	–	–	2.37	1	2.37	6	.39
IV. Awuni ...	3.22	–	–	3.22	2	1.61	10	.32
V. Atia ...	2.75	–	–	2.75	1	2.75	3	.92
VI. Asoro ...	7.56	–	–	7.56	4	1.96	8	.99
VII. Abugbiri	2.04	–	1.01	3.05	2	1.52	9	.34
VIII. Ayenpam	1.44	–	1.04	2.48	1	2.48	6	.41
Totals ...	34.24	4.75	2.05	41.04	17	–	75	–
Means ...	4.28	.59	.26	5.13	2.1	2.44	9.4	.55
SUMMARY OF DATA FOR 29 COMPOUNDS IN ZUARUNGU AREA								
Totals ...	124.11	40.63	34.45	199.17	98	–	366	–
Means ...	4.28	1.40	1.19	6.87	3.7	2.03	12.6	.54

*Receive assistance. **Two men very old. ***Poor, eroded land.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 2.

NAVRONGO AREA.

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Details of areas farmed (in acres), men farming and persons supported upon 20 recorded compounds at four centres in the Navrongo Area. Surveyed 1934 and 1935.

Compound No. and Name of Owner	Area farmed				No. men farming	Area per man	No. persons supported	Area per person
	Compound Farm	Separate "not bush"	Bush Farm	Total				
Chana—								
I. Kaba ...	9.75	–	–	9.75	4	2.44	13	.75
II. Awesoga...	7.73	–	–	7.73	3	2.58	9	.86
III. Sotia ...	5.78	–	–	5.78	3	1.93	5	1.16
IV. Bagani ...	12.00	1.41	–	13.41	3	4.47	12	1.12
V. Agulun ...	9.29	–	–	9.29	1	9.29*	5	1.86
VI. Ajenyima	9.78	–	–	9.78	2	4.89	5	1.96
Totals ...	54.33	1.41	–	55.74	16	–	49	–
Means ...	–	–	–	9.29	2.6	3.48	8.1	1.14
Kologo—								
I. Atinga ...	6.55	–	2.39	8.94	4	2.24	10	.89
II. Ayamaga	1.84	3.27	3.84	8.95	2	4.48	15	.59
III. Agbona ...	4.69	–	14.83	19.52	4	4.88	19	1.03
IV. Adawuni...	5.39	.67 .51 .64	1.91	9.12	2	4.56	11	.83
V. Brema ...	2.87	–	–	2.87	2**	1.44	17	.17
VI. Abonga ...	8.41	–	7.00	15.41	2	7.71	11	.70
Totals ...	29.75	5.09	29.97	64.81	16	–	83	–
Means ...	–	–	–	10.80	2.6	4.05	12.9	.78
Navrongo—								
I. Abolga ...	3.71	1.55 1.66	–	6.92	3	2.34	7	1.00
II. Kajuga ...	5.19	3.35	–	8.54	6	1.44	26	.33
Totals ...	8.90	6.56	–	15.46	9	–	33	–
Means ...	4.45	3.28	–	7.73	4.5	1.72	16.5	.47

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 2 (continued).

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Compound No. and Name of Owner	Area farmed				No. men farming	Area per man	No. persons supported	Area per person
	Compound Farm	Separate "not bush"	Bush Farm	Total				
Wiaga—								
I. Abasu ...	3.12	.76 .46	–	4.34	3	1.45	10	.43
II. Akulbalmni	4.62	.89 .77 .57	–	6.85	2	3.43	8	.86
III. Anisedi ...	1.07	3.20	–	4.27	1	4.27	4	1.07
IV. Amanyadi	3.99	2.03	–	6.02	4	1.51	9	.67
V. Azurumi	2.86	1.01	–	3.87	2	1.94	12	.32
VI. Ansodi ...	1.87	.37	–	2.24	1	2.24	9	.25
Totals ...	17.53	10.06	–	27.59	13	–	52	–
Means ...	–	–	–	4.59	2.1	2.12	8.6	.53
SUMMARY OF DATA FOR 20 COMPOUNDS IN NAVRONGO AREA								
Totals ...	110.51	23.12	29.97	163.60	54	–	217	–
Means ...	5.52	1.16	1.49	8.19	2.7	3.03	10.8	.75

*Farmed very extensively. **One man a tailor.

APPENDIX II—TABLE 3.

KUSASI AREA.

Details of areas, men farming, and persons supported at Zebilla. Surveyed 1936.

241
311
162

Compound No. and Name of Owner	Areas farmed, in acres				No. men farming	Area per man	No. persons supported	Area per person
	Compound Farm	Separate "not bush"	Bush Farm	Total				
Zebilla—								
I. Mbila ...	1.58	–	6.37	7.95	1	8.18	4	2.04
II. Abila ...	4.62	–	9.62	14.24	6	2.4	22	.65
III. Agbanbila	4.26	–	4.30	8.56	4	2.16	9	.96
IV. Akobari ...	14.70	5.94	3.76	24.40	6	4.31	17	1.52
V. Aroko ...	4.22	3.23	5.71	13.16	4	3.30	15	.88
Totals ...	29.38	9.17	29.76	68.31	21	–	67	–
Means ...	5.88	1.83	5.95	13.66	4.2	3.25	13.4	1.02

241
311
162

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 4.

Summary of Tables 1—3 giving totals and means for 54 compounds surveyed at ten centres in North Mamprusi. (Allowance has been made in areas for land occupied by buildings or waste land. "Persons supported" includes adults and children, except babes in arms.)

District and Centre of Record	No. of Compound	Area farmed in acres				Total Number men farming	Area per man	Total Number persons supported	Area per person	Compound Means			Persons supported per man
		Compound Farm	Farm away *not* bush	Bush Farms	Total Area					Area farmed	Men farming	Persons supported	
Zuarungu Area—													
Bongo ...	6	15.47	15.70	—	31.17	18	1.73	60	.51	5.19	3	10	3.3
Nangodi ...	5	27.56	1.75	10.69	40.00	20	2.00	84	.48	8.00	4	16.8	4.2
Sambruno ...	5	26.45	9.24	—	35.69	20	1.78	52	.68	7.14	4	10.4	2.6
Tongo ...	5	20.39	9.19	21.69	51.27	23	2.23	95	.54	10.25	4.6	19	4.1
Zuarungu ...	8	34.24	4.75	2.05	41.04	17	2.44	75	.55	5.13	2.1	9.4	4.4
Navrongo Area—													
Chana ...	6	54.33	1.42	—	55.74	16	3.48	49	1.14	9.29	2.6	8.1	3.1
Kologo ...	6	29.75	5.09	29.97	64.81	16	4.05	83	.78	10.80	2.6	12.9	4.9
Navrongo ...	2	8.90	6.56	—	15.46	9	1.74	33	.47	7.73	4.5	16.5	3.6
Wiaga ...	6	17.53	10.06	—	27.59	13	2.12	52	.53	4.59	2.1	8.6	4.1
Kusasi Area—													
Zebilla ...	5	29.38	9.17	29.76	68.31	21	3.25	67	1.02	13.66	4.2	13.4	3.2
Totals ...	54	264.00	72.92	94.16	431.08	173	—	650	—	—	—	—	—
Means ...	—	4.89	1.35	1.74	7.98	3.2	2.49	12	.66	7.98	3.2	12	3.7
		61%	17%	22%									

241
311

Summary of Cropping at 10 Centres of Record in

District :	Zuarungu Area (1932)					
Centre of Record :	Bongo	Nangodi	Sambruno	Tongo	Zuarungu	Tota 29 comp
No. of compounds recorded :	6	5	5	5	8	acres
Cereals—						
Early millet Late millet Groundcrops*	6.90 (1.71)	7.44 (1.28)	1.04 (.62)	11.91 (6.79)	18.99 (4.19)	46.28 (14.59)
Early millet Guinea corn Groundcrops	9.79 (2.47)	9.80 (1.46)	6.35 (.81)	4.44 (2.89)	5.90 (.72)	36.28 (8.35)
Early millet Late millet Guinea corn Groundcrops	2.98 (1.06)	–	13.15 (6.68)	–	5.32 (1.90)	21.45 (9.64)
Late millet Groundnuts	2.04	5.42	3.81	2.53	2.25	16.05
Late millet Groundcrops	–	.84	.63	19.03	3.23	23.73
Guinea corn Groundcrops	5.69 (1.10)	15.41	1.15 (.83)	11.98	1.22	35.45 (1.93)
Late millet Guinea corn Groundcrops	–	–	2.05	.98	.65	3.68
Rice	–	–	.58	–	.01	.59
Maize	–	–	–	.08 (.02)	.02	.10 (.02)
Legumes—						
Groundnuts	3.70	.75	3.35	–	2.17	9.97
Bambarra beans	–	.14	.14	–	–	.28
Groundnuts Bambarra beans	–	–	3.17	–	.74	3.91
Kerstingrella geocarpa	–	.09	.09	.11	–	.29
Root Crops—						
Coleus potatoes	–	–	–	–	.32	.32
Sweet potatoes	–	–	.02	.21	.22	.45
Miscellaneous—						
Tobacco	–	.11	.02	–	–	.13
Okra	.07	–	–	–	–	.07
Hibiscus cannabinus	–	–	.14	–	–	.14
Total Cereals Percentage	27.40 (6.34) 88	38.91 (2.74) 97	28.76 (8.94) 80	50.95 (9.70) 99	37.59 (6.81) 91	183.61 (34.53) –
Total Legumes Percentage	3.70 12	.98 2	6.75 19	.11 –	2.91 7	14.45 –
Total Roots Percentage	– –	– –	.02 –	.21 –	.54 1	.77 –
Total Miscellaneous... Percentage	.07 –	.11 1	.16 –	– –	– –	.34 –
Total Area cultivated	31.17	40.00	35.69	51.27	41.04	199.17

*Ground crops — neri and cowpeas.

[p. 70A-i]

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 5.

tres of Record in North Mamprusi. (All areas are given in acres. Figur

241
311

(1932)			Navrongo Area (1934 and 1935)						1
Zuarungu	Total 29 compounds		Chana	Kologo	Navrongo	Wiaga	Total 29 compounds		
8	acres	%	6	6	2	6	acres	%	
18.99 (4.19)	46.28 (14.59)	23	1.62	5.01	–	.31	6.94	4.2	
5.90 (.72)	36.28 (8.35)	16	4.27 (3.29)	9.03	.73	4.40	19.33 (3.29)	11.8	
5.32 (1.90)	21.45 (9.64)	10	16.83	12.17 (2.93)	7.08 (4.05)	19.20	55.28 (6.98)	33.8	
2.25	16.05	8	1.93	1.31	–	–	3.24	1.9	
3.23	23.73	11	5.27	16.63	3.26	.26	25.42	15.3	
1.22	35.45 (1.93)	17	7.11	5.20	1.74	–	14.05	8.6	
.65	3.68	1.8	6.82	7.04	.53	.31	14.70	9	
.01	.59	.24	1.25	2.96	.26	–	4.47	2.7	
.02	.10 (.02)	.05	–	–	.05	–	.05	.03	
2.17	9.97	5	1.99	2.91	1.66	1.17	7.73	4.7	
–	.28	.14	–	.56	–	–	.56	.3	
.74	3.91	1.95	8.57	1.09	–	1.78	11.44	7	
–	.29	.14	–	–	–	.16	.16	.09	
.32	.32	.16	.05	–	.15	–	.20	.01	
.22	.45	.22	–	–	–	–	–	–	
–	.13	.06	–	–	–	–	–	–	
–	.07	.03	.03	–	–	–	.03	–	
–	.14	.07	–	–	–	–	–	–	
37.59 (6.81) 91	183.61 (34.53) –	– 92	45.10 (3.29) 81	60.25 (2.93) 93	13.65 (4.05) 88	24.48 89	143.18 (10.27) –	– 87.5	
2.01 7	14.45 –	– 7	10.56 19	4.86 7	1.66 11	3.11 11	19.99 –	12.1 –	
.54 1	.77 –	– .40	.05 –	– –	.15 1	– –	.20 –	.12 –	
– –	.34 –	– .1	.03 –	– –	– –	– –	.03 –	– –	
41.04	199.17	–	55.74	64.81	15.46	27.59	163.60	–	

[p. 70A-ii]

are given in acres. Figures in brackets denote area manured.)

241
311

934 and 1935)			Kusasi Area (1936)		Total, 34 compounds at 10 centres		Type of farm where commonly planted: Compound: Type (I) and Type (II) Bush: Type (III)
Wiaga	Total 20 compounds		Zebilla				
6	acres	%	6 acres	%	acres	%	
.31	6.94	4.2	14.21 (5.97)	20 (9)	67.43 (20.56)	15.6 (4.7)	Compound
4.40	19.33 (3.29)	11.8	12.47 (4.36)	18.2 (6)	68.08 (16.00)	15.8 (3.7)	Compound
19.20	55.28 (6.98)	33.8	–	–	76.73 (16.62)	17.9 (3.8)	Compound
–	3.24	1.9	–	–	19.29	4.6	Compound
.26	25.42	15.3	18.28	26.7	67.43	15.6	Bush and compound
–	14.05	8.6	19.73	28.8	69.23 (1.93)	16 (.45)	Bush and compound
.31	14.70	9	–	–	18.38	4.2	Bush and compound
–	4.47	2.7	.06	–	5.12	1.2	Compound
–	.05	.03	.05 (.05)	– (.06)	.20 (.07)	.04	Compound
1.17	7.73	4.7	2.17	3.1	19.87	4.6	Compound
–	.56	.3	–	–	.84	.2	Compound
1.78	11.44	7	–	–	15.35	3.5	Compound
.16	.16	.09	–	–	.45	.1	Compound
–	.20	.01	1.29	1.8	1.81	.4	Compound
–	–	–	–	–	.45	.1	Compound
–	–	–	–	–	.13	.03	Compound
–	.03	–	–	–	.10	.02	Compound
–	–	–	.05	.07	.19	.04	Compound
24.48 89	143.18 (10.27) –	– 87.5	64.80 (10.38) –	– (15) 94	391.89 (55.18) –	– (12) 91	
2.11 11	19.89 –	12.1 –	2.17 –	– 3.1	36.51 –	– 8.4	
– –	.20 –	.12 –	1.29 –	– 1.8	2.26 –	.5 –	
– –	.03 –	– –	.05 –	.1 –	.42 –	.1 –	
27.59	163.60	–	68.31	–	431.06	–	

[p. 70A - iii]

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

241

Analysis of Yield Data in North Mamprusi, 19

ZUARUNGA

Mixtures of Crops	1932		1934*		1935*	
	Unmanured	Manured	Unmanured	Manured	Unmanured	
Early millet ... ... late millet and groundcrops (neri and cowpeas)	397 (4) 535	625 (9) 762	254 (4) 480 (4)	344 (7) 444 (7)	355 (14) 291	
Early millet guinea corn and groundcrops	286 (40) 422	528 (14) 574	204 (20) 507	270 (4) 553	517 (10) 339	5 5
Early millet late millet guinea corn and groundcrops	384 (29) 125 350 —	406 (9) 100 461 —	203 (4) 175 320	—	—	
Late millet and groundcrops	282 (9)	—	240 (1)	—	—	
Guinea corn and groundcrops	413 (4)	—	—	—	210 (2)	
Late millet guinea corn and groundcrops	186 (2) 82 (2)	—	—	—	—	
Rice	350 (1)	—	—	—	—	
Late millet groundnuts	159 (13) 582	—	156 (4) 1140	—	—	
Legumes— groundnuts	560 (35)	—	820 (3)	—	860 (15)	
Bambarra beans	487 (5)	—	—	—	—	
Groundnuts Bambarra beans	247 (7) 132		885 (2) 78	—	—	
Cowpeas	78 (123)	102 (49)	84 (29)	77 (13)	106 (34)	
Coleus potatoes	357 (10)	—	—	—	—	
Sweet potatoes	4284 (6)	—	—	—	—	
neri (Cucumis melo)	23 (123)	28 (48)	19 (23)	11 (27)	56 (24)	

*Compound farms only. **Records from two compounds at Chana and two a

[p. 708-i]

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 6.

North Mamprusi, 1932-1936. (All yields in lbs. per acre. Figures in bra

ZUARUNGA AREA								
1934*		1935*		1936*		Summary		193
4	Manured	Unmanured	Manured	Unmanured	Manured	Unmanured	Manured	Unmanured
)	344 (7)	355 (14)	—	337 (11)	—	370 (69)	502 (16)	203 (11)
)	444 (7)	291	—	411	—	462	623	329 (11)
)	270 (4)	517 (10)	560 (6)	410 (6)	550 (3)	304 (76)	500 (27)	268 (36)
	683	329	588	501	744	450	608	272
)	—	—	—	—	—	362 (33)	406 (9)	233 (62)
						133	100	184
						346	461	182
)	—	—	—	—	—	278 (10)	—	207 (38)
	—	210 (2)	—	—	—	345 (6)	—	126 (27)
	—	—	—	—	—	186 (2)	—	118 (22)
						82		91
	—	—	—	—	—	350 (1)	—	632 (11)
)	—	—	—	—	—	188 (17)	—	106 (4)
						725		623
)	—	860 (15)	—	—	—	660 (53)	—	631 (12)
	—	—	—	—	—	487 (5)	—	—
)	—	—	—	—	—	388 (9)	—	469 (25)
						120	—	83
)	77 (13)	106 (24)	81 (16)	93 (11)	—	80 (187)	95 (68)	49 (191)
	—	—	—	—	—	3572 (10)	—	1662 (6)
	—	—	—	—	—	4284 (6)	—	2400 (2)
)	11 (27)	56 (24)	45 (16)	—	—	27 (170)	28 (91)	51 (196)

pounds at Chana and two at Navrongo.

[p. 70B-ii]

NDIX II—TABLE 6.

241 ere. Figures in brackets denote number of sample plots from which each m

	NAVRONGO AREA						
mary	1934		1935		1936**		Summ
Manured	Unmanured	Manured	Unmanured	Manured	Unmanured	Manured	Unmanured
502 (16) 623	203 (11) 329 (11)	— —	146 (3) 403	985 (1) 280	—	—	191 (14) 330
500 (27) 606	266 (36) 272	395 (13) 395	377 (16) 352	821 (16) 458	497 (1) 240	—	305 (53) 295
406 (9) 100 461	233 (62) 184 182	445 (13) 117 300	281 (13) 76 275	572 (15) 72 436	388 (9) 168 483	586 (8) 87 779	252 (84) 166 228
—	207 (38)	—	284 (9)	—	—	—	222 (47)
—	126 (27)	—	292 (5)	—	—	—	152 (32)
—	118 (22) 91	— —	82 (1) 620	— —	— —	— —	116 (23) 113
—	632 (11)	—	746 (7)	—	950 (2)	—	703 (20)
—	106 (4) 623	— —	110 (2) 606	— —	— —	— —	107 (6) 617
—	631 (12)	—	540 (3)	—	—	—	613 (15)
—	—	—	—	—	—	—	—
— —	469 (23) 83	—	759 (12) 96	— —	687 (12) 362	—	597 (50) 153
93 (68)	49 (191)	58 (26)	59 (19)	49 (23)	—	—	50 (210)
—	1662 (6)	—	—	—	—	—	1662 (6)
—	8400 (2)	—	—	—	—	—	8400 (2)
36 (91)	51 (196)	58 (30)	11 (13)	11 (10)	—	—	48 (309)

[p. 708-iii]

241 s from which each mean was obtained.)

			ZEBILLA			
36**	Summary		1936		Summary for all data	
Manured	Unmanured	Manured	Unmanured	Manured	Unmanured	Manured
—	191 (14) 330	985 (1) 280	145 (10) 119	378 (17) 241	319 (93) 406	455 (34) 422
—	305 (53) 295	630 (29) 430	160 (11) 257	489 (12) 568	293 (140) 376	553 (68) 525
586 (8) 87 779	252 (84) 166 228	529 (36) 91 463	— —	— —	282 (117) 156 261	505 (45) 93 462
—	222 (47)	—	253 (22)	—	238 (79)	—
—	152 (32)	—	539 (36)	—	356 (74)	—
— —	116 (23) 113	— —	— —	— —	122 (25) 111	— —
—	703 (20)	—	—	—	687 (21)	—
— —	107 (6) 617	—	— —	— —	145 (23) 688	— —
—	613 (15)	—	389 (4)	—	635 (72)	—
—	—	—	—	—	487 (5)	—
—	597 (50) 153	—	— —	— —	565 (59) 148	
—	50 (210)	54 (49)	42 (79)	85 (29)	62 (366)	79 (146)
—	1662 (6)	—	5057 (3)	—	3456 (19)	—
—	5400 (2)	—	—	—	5313 (8)	—
—	48 (209)	45 (36)	—	—	39 (379)	31 (127)

[p. 70B-iv]

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 7.

Analysis of yield data for the more important crops grown in North Mamprusi showing yield per crop, irrespective of mixture.

(Figures in brackets denote number of sample plots from which each mean was obtained.)

Crop	Unmanured or Manured	Zuarungu Area				Navrongo Area			Zebilla	Weighted Mean for all data
		1932	1934	1935	1936	1934	1935	1936	1936	
Early millet ...	Unmanured	353(109)	193 (32)	422 (24)	362 (17)	242(109)	323 (13)	438 (15)	153 (21)	271(358)
	Manured	523 (52)	317 (11)	560 (6)	550 (3)	419 (26)	618 (26)	857 (6)	425 (29)	506(159)
Late millet... ...	Unmanured	349 (80)	248 (25)	258 (19)	411 (10)	185(147)	123 (28)	176 (1)	211 (32)	236(342)
	Manured	431 (18)	308 (11)	—	—	117 (13)	59 (18)	107 (3)	241 (17)	227 (80)
Guinea corn ...	Unmanured	395 (75)	464 (26)	317 (12)	510 (6)	193(154)	322 (35)	535 (20)	473 (47)	326(375)
	Manured	530 (23)	539 (8)	588 (6)	744 (3)	360 (26)	378 (26)	870 (6)	568 (12)	486(110)
Rice	Unmanured	350 (1)	—	—	—	632 (11)	746 (7)	950 (2)	—	687 (21)
Groundnuts ...	Unmanured	489 (67)	757 (13)	860 (5)	—	595 (47)	—	776 (13)	389 (4)	594(169)
Bambarra beans ...	Unmanured	251 (12)	78 (2)	—	—	95 (31)	—	441 (3)	—	155 (48)
Cowpeas	Unmanured	78(123)	64 (29)	106 (24)	93 (11)	49(191)	59 (19)	—	42 (79)	62(366)
	Manured	102 (49)	77 (13)	81 (6)	—	58 (26)	49 (23)	—	85 (29)	79(146)
"Neri"	Unmanured	23(123)	19 (23)	56 (24)	—	51(196)	11 (13)	—	—	38(379)
	Manured	28 (48)	11 (27)	45 (6)	—	58 (26)	11 (10)	—	—	31(127)
Coleus potatoes ...	Unmanured	3,752 (10)	—	—	—	1,662 (6)	—	—	6,057 (3)	3,456 (19)
Sweet potatoes ...	Unmanured	4,284 (6)	—	—	—	8,400 (2)	—	—	—	5,313 (8)

[P. 72 is blank]

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

Giving an analysis of the livestock o

231
435

Livestock	Value in Units†	Bongo						Nangodi				
		I	II	III	IV	V	VI*	I	II*	III	IV	V*
Cattle	60	8	–	–	1	–	3	–	4	6	1	2
Donkeys	30	1	–	–	1	–	2	–	–	2	–	–
Sheep	10	–	–	1	2	–	6	–	15	4	1	3
Goats	5	10	–	1	6	–	7	–	25	4	1	5
Fowls	1	15	–	–	10	1	10	–	16	15	5	20
Guinea fowls ...	1	–	–	–	–	–	8	–	25	14	3	16
Horses	160	–	–	–	–	–	–	–	–	–	–	–
Total Units ...		605	nil	18	163	1	374	–	631	641	86	276

NAVRONGO

Livestock	Value in Units	Chana						Kologo				
		I*	II	III	IV*	V	VI	I	II	III*	IV	V
Cattle	60	3	–	–	1	–	3	3	–	6	–	–
Donkeys	30	–	–	–	3	–	1	–	–	–	–	1
Sheep	10	–	–	–	5	2	2	1	2	7	3	7
Goats	5	5	–	–	5	2	2	–	–	1	4	2
Fowls	1	23	9	2	34	10	–	17	8	10	15	30
Guinea fowls ...	1	21	2	2	10	7	–	–	–	5	9	6
Horses	160	–	–	–	–	–	–	–	–	–	–	–
Total Units ...		288	11	4	274	53	248	207	28	453	86	142

*Compounds suffering no shortage of cultivated foods during the previous year.

†The unit is taken to be the fowl and all other classes of stock are related to it at roughly their since it does not take into account the age of the stock. The unit is useful for comparing the stock

[p. 72A-i]

[p. 72 is blank]

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX II—TABLE 8.

the livestock owned by 54 compounds at 10 centres in North Mamprusi.

231
435

ZUARUNGU AREA (April, 1932)

...gedi			Sambruno					Tongo					Zuarungu				
			Compound No.														
I	IV	V*	I	II	III	IV	V	I*	II	III	IV*	V	I*	II*	III	IV	V
8	1	2	3	–	2	1	–	3	–	1	6	–	3	3	–	–	–
2	–	–	–	–	–	–	–	2	–	–	–	–	–	1	–	2	–
4	1	8	8	8	3	10	–	–	6	8	–	4	9	–	–	3	–
4	1	5	2	5	6	8	2	–	4	4	6	4	5	10	10	1	3
5	5	20	25	6	24	10	7	–	12	36	7	20	20	7	6	1	4
4	3	16	6	5	8	11	–	27	4	5	11	40	12	3	–	–	6
	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	
1	86	276	307	131	230	245	23	267	108	213	586	132	342	300	66	96	34

NAVRONGO AREA (April, 1934)

Kolego				Navrongo		Wiaga						Total 20 compounds	Mean	K	
														Z	
I*	IV	V	VI	I*	II*	I	II	III	IV*	V	VI*			I	II
6	–	–	–	6	–	7	3	–	8	5	3	48	2.4	–	–
-	–	1	–	1	–	1	1	–	1	–	1	10	.5	–	–
7	3	7	3	5	11	–	–	–	6	3	5	62	3.1	–	–
1	4	2	4	4	7	8	4	–	4	8	7	70	3.5	–	12
10	15	20	15	–	20	17	6	8	20	8	6	238	11.9	4	10
8	9	6	9	–	7	7	10	–	10	8	5	118	5.9	4	10
-	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
38	86	142	86	472	198	538	258	8	632	410	327	4,716	236	8	276

t at roughly their exchangeable value. It is purely arbitrary
mparing the stocking on different compounds.

[p. 72 A-ii]

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

rusi.

231
435

Zuarungu						Total 29 compounds	Mean
III	IV	V	VI	VII	VIII		
–	–	–	3	3	–	55	1.9
–	2	–	1	–	–	12	.4
–	3	–	13	–	–	109	3.7
10	1	3	15	–	1	145	5
6	1	4	–	9	3	289	10
–	–	6	14	–	–	218	7.5
–	–	–	–	–	–	1	–
86	99	34	474	189	11	6,577	226

san	KUSASI AREA (1936)						
	Zebilla					Total 5 compounds	Mean
	I	II	III	IV	V		
2.4	–	–	–	2	–	2	.4
.5	–	–	–	2	2	4	.8
3.1	–	–	–	10	2	12	2.4
3.5	–	12	–	4	4	20	4
1.9	4	10	6	5	15	40	8
1.9	4	10	–	–	9	23	4.75
	–	–	–	–	1	1	.2
36	8	276	6	317	136	743	148

LIVESTOCK OWNED BY 54 COMPOUNDS IN NORTH MAMPRUSI

	Total	Mean
Horses	2	–
Cattle	105	1.9
Donkeys	26	.5
Sheep	183	3.4
Goats	235	6.2
Fowls	567	10.5
Guinea fowls ...	359	6.6
Units ...	12,036	223

[p. 72A-iii]

7

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX III.

241
824

List of crops more commonly grown in North Mamprusi with their botanic and local native names.

Crop	Nankani	Kassena	Builsa
Early millet (Pennisetum typhoides, var.)	Nara	Chara	Nara
Late millet (Pennisetum typhoides, var.)	Zia	Mumpuana	Zia
Guinea corn (Sorghum vulgare) ...	Tchee*	Yara	Zamonta
Maize (Zea mays)	Kañana	Kamana	Tumbena
Rice (Oryza sativa)	Mui	Mumulinga	Mua
Groundnuts (Arachis hypogea) ...	Sunkpam	Sunoga	Sunkpa
Bambarra beans (Voandzeia subterranea)	Suma	Sinonu	Suma
Geocarpa beans (Kerstingiella geocarpa)	Sumperga	—	Sulumperg
Cowpeas (Vigna spp.)	Tia	Snona	Tua
Yams (Dioscorea spp.)	Nyuya	Pia	Nyuya
Sweet potatoes (Ipomoea batatus) ...	Nyimbemto	Nanuri	Nambanura
Coleus potatoes (Coleus dysentericus) ...	Pearsa	Yia	Pisa
Cassava (Manihot utilissima)	Banchi	Manchi	Banchib
Okra (Hibiscus esculentus)	Ma-ana	Ma-ana	Ma-ana
Hibiscus (short) (Hibiscus sabdariffa)...	Bito	Puora	Suri
Hibiscus (long) (Hibiscus cannabinus)...	Bersi	Kasoga	Kasoga
Soup plant (Gynandropsis pentaphylla)	Nangina	Kalema	Karabacho
Neri (Cucumis melo)	Sama	Yakoro	Bura
Calabash (Lagenaria vulgaris)	Tungu	Zonga	Chin
Calabash (bottle shaped) (Lagenaria vulgaris)	Linka	Konkolu	—
Pumpkin (Curcubita pepo)	Yogari	—	—
Bungu (Ceratotheca sesamoides) ...	Suri	Suru	Boarta
Sesame (Sesamum indicum)	Sasam	Buum	Bunsiug

*Note.—Tchee is also used as a general term for cereals, rather in the same way that we use the word "corn."

[p. 74 is blank]

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV.

654

MEAN YIELDS FROM EXPERIMENTS.

ROTATIONS.

Table 1.—Rotation Experiment, Sabiya.

„ *2.*—8 acre Unit Holding Experiment, Navrongo.

CULTIVATION EXPERIMENTS.

Table 3.—Ridge cultivation v. Native method at Goragu.

„ *4.*—Ridge cultivation v. Flat cultivation v. Native method at Yekeni.

„ *5.*—Ridge v. Flat v. Native at Zuarungu.

„ *6.*—Ransomes M.S.N. plough v. Native method at Zuarungu.

„ *7.*—Ransomes "Victory" plough v. Native method at Zuarungu.

MANURING EXPERIMENTS.

Table 8.—Analysis of Manures used at Zuarungu in 1936—Native compost, "Indore" compost, and farmyard manure.

„ *9.*—Manurial Trial on sweet potatoes and residual values, Navrongo.

„ *10.*—Manurial Trial on Coleus potatoes, Navrongo.

„ *11.*—Manurial Trial on Cereals, Navrongo.

„ *12.*—"Indore" compost v. "Native", Zuarungu.

„ *13.*—"Indore" compost v. Farmyard manure, Zuarungu.

ROOT CROPS.

Table 14.—Yam Variety Trials, Navrongo.

„ *15.*—Yam Variety Trials, Yekeni.

„ *16.*—Sweet Potato Variety Trials.

MISCELLANEOUS TRIALS.

Table 17.—Groundnut Variety Trials, Zuarungu.

„ *18.*—Rice Variety Trials, Zuarungu.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 1.

ROTATION EXPERIMENT, SABIYA.

(Exp.: No. 1/34, 1/35, and 1/36.)

654 An experiment started in 1934 to test the best means of developing "bush" land.

Layout.—Latin Square.

Replications.—5.

Size of Plots.—1/20th acre.

Mean yields in lbs. per acre for years 1934, 1935 and 1936.

Cropping		1934	1935	1936
A—	Yams	3,124 lbs. tubers	860 lbs.	failed
	millet	(not planted)	—	306 lbs. grain
B*—	Early millet	failed	123 lbs.	240
	guinea corn	87 lbs. grain	122	failed (locusts)
C—	Early millet	failed	100 lbs.	78
	late millet	257 lbs.	178 lbs.	238
D—	Early millet	failed	99 lbs.	36
	groundnuts	164 lbs.	307 lbs.	323
N**—	(Native method)			
	Early millet	—	42	—
	late millet	—	131	—
	alternated with			
	Early millet	failed		16
	guinea corn	54	—	failed (locusts)

*Manured at rate of 2 tons per acre in 1935 and 1936. No manure applied in 1934.

**Native method. This is not exactly what a native would do since no early millet is planted in 'bush' farms.

Note.—Failures are due mainly to the ravages of pests. So far yields do not give a true picture of the condition of this experiment. It is too early to draw any conclusions from this experiment.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 2.

8 ACRE UNIT HOLDING EXPERIMENT, NAVRONGO.

654

(Exp.: No. 2/35, and 2/36.)

Mean yields per acre from 4 fields each of two acres, worked by one man, his wife and a boy, as a mixed farm unit, with two working bullocks, a ridging plough and cultivator.

Cropping	1935		1936	
	Field	Yield	Field	Yield
Yams (½ acre)	C	17.6 cwts.	B	31 cwts.
Sweet potatoes (1 acre)		49.7 ,,		20.3 ,,
Coleus potatoes (½ acre)...		26.5 ,,		10.8 ,,
Cassava (½ acre)		—		120 ,,
Early millet*	D	36 lbs.	C	86 lbs.
guinea corn		215 ,,		331 ,,
cowpeas		20 ,,		103 ,,
Early millet	A	45 lbs.	D	42 lbs.
late millet		288 ,,		73 ,,
cowpeas		12 ,,		52 ,,
Early millet (½ acre)	B	107 lbs.	A	failed
groundnuts		115 ,,		442 lbs.
Early millet		failed		failed
Bengal beans		no weights		12½ cwts. hay

*Manured 2 tons dung per acre. Farmyard manure available for 1937 season.

Conclusion.

A man and his wife with the assistance of a small boy can farm fairly easily 8 acres cropped as above. Experience may suggest desirable modifications.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 3.

654 CULTIVATION EXPERIMENT IN THE HEADMAN OF GORAGU'S COMPOUND FARM.

(Exp. : Nos. 7/34, 5/35, and 4/36.)

Treatments.—2. To test cultivation before planting on 3' ridges against native practice.

Layout.—Strip method.

Replications.—11.

Size of Plots.—1/20th acre.

Mean yields per acre of grain.

Season	Cropping	Native	Ridged
1934	Early millet	535	980
	guinea corn	66	108
1935	Early millet	660	1,048
	guinea corn	29	472
1936	Early millet	897	1,276
	guinea corn	183	500
Combined grain yield from 1 acre in three years ...		2,370 lbs.	4,384 lbs.

Note.—Cultivations in 1934 and 1935 were done by hand. In 1936 with DY ridging plough. Differences definitely statistically significant in each year.

Conclusion.

There can be no doubt whatever as to the value of ridging under the conditions of this trial. Goragu lies at the foot of the Tong Hills on the North side between Tongo and Shia.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654

APPENDIX IV—TABLE 4.

CULTIVATION EXPERIMENT IN THE COMPOUND FARM OF THE HEADMAN OF YEKENI.

(Exp.: Nos. 8/34, 6/35, and 5/36.)

Treatments.—3. To test cultivation before planting on 3' ridges, in rows 3' apart on the flat, against control, native practice.

Mean yields in lbs. of grain per acre.

Year	Cropping	Native	Ridged	Flat
1934	Early millet	17	87	—
	guinea corn	321	270	—
1935	Early millet	219	271	214
	guinea corn	100	145	198
1936	Early millet	305	420	376
	late millet	133	140	144

Note.—Cultivations in 1934 and 1935 done by hand. In 1936 with animal cultivation.

Conclusion.

Definite advantage in favour of cultivation before planting. No difference between ridge and flat. Manuring would probably have an effect. All yields are poor.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654

APPENDIX IV—TABLE 5.

CULTIVATION EXPERIMENT ON THE EXPERIMENT AREA AT ZUARUNGU.

(Exp.: Nos. 6/34, 7/35, and 6/36.)

Treatments.—3. To test cultivation before planting on 3′ ridges, in rows 3′ apart on flat against native method.

Layout.—Chessboard.

Size of Plots.—1/40th acre.

Replications.—9.

Mean yields per acre.

Year	Cropping	Control Native	Ridged	Flat
1934	Early millet	63	87	149
	guinea corn	267	241	581
1935	Early millet	150	332	256
	guinea corn	15	36	29
1936	Early millet	156	189	248
	late millet	178	231	292

Conclusion.

Yields are very low and can be accepted only with caution. The balance appears to be in favour of ridging if all factors are taken into consideration—ease of planting and intercultivation, etc.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 6.

654

CULTIVATION EXPERIMENT IN COMPOUND FARM OF ADACHAMA, ZUARUNGU (1936).

(Exp. No. 7/36.)

Treatments.—2. To test cultivation with Ransomes M.S.N. single furrow plough before planting, against Native practice.

Layout.—Strip method.

Replications.—5.

Size of Plots.—1/20th acre.

Mean yields in grain per acre.

Cropping	Control Native	Ploughed
Early millet	366 lbs.	396 lbs.
late millet	556 „	602 „
cowpeas	40 „	44 „

Conclusion.

Taking the small number of replications into consideration the difference in yield is only barely significant $\left(\frac{\text{Md}}{\text{s.e.}} = 2.5\right)$. The value of the work was in the ease of cultivation and the cleanliness of the ground in the early stages.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 7.

654 CULTIVATION EXPERIMENT IN COMPOUND FARM OF ABAGNA, ZUARUNGU (1936).

(Exp.: No. 8/36.)

Treatments.—2. To test cultivation with Ransomes "Victory" plough (single furrow) before planting, against native method.

Layout.—Strip method.

Replications.—5.

Size of Plots.—1/20th acre.

Mean yields in grain per acre.

Cropping	Control Native	Ploughed
Early millet	321 lbs.	401 lbs.
late millet	283 ,,	336 ,,
cowpeas	137 ,,	132 ,,
neri	59 ,,	64 ,,

Conclusion.

These differences did not prove statistically significant but as in Experiment 7/36, ploughing effected a great saving of labour at a critical season.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654

APPENDIX IV—TABLE 8.

ANALYSES OF MANURES USED AT ZUARUNGU IN 1936.

(Analyses carried out by the Agricultural Chemist, Mr. M. Greenwood.)

(Analyses on air dried, fine samples.)

	Native Compost	Zuarungu-made	
		"Indore" Compost	Farmyard Manure
Moisture	3.8	6.2	6.6
Insol. ash	78.8	77.2	67.9
Sol. ash	6.1	6.4	7.4
Loss on ignition	11.3	10.2	18.1
Nitrogen (including nitrates)	.47	.61	.68
P O...	.36	.32	.71
K O	.79	.34	1.13

Note.—The analyses show values on the low side. Those for "Indore" compost and farmyard manure are comparable with published Indian figures.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 9.

654 MANURIAL TRIAL UPON SWEET POTATOES AT NAVRONGO IN 1934, AND THE RESIDUAL MANURIAL EFFECT UPON MIXED CEREALS IN 1935 AND 1936.

(Exp.: Nos. 9/34, 9/35, 12/36.)

To test 4 tons of manure (leached-out cattle dung from Native Administration kraal) against control, "no manure".

Layout.—Strip method.

Replications.—6.

Size of Plots.—1/20th acre.

Mean yields per acre in lbs.

Year	Crop	Control no manure	Manured 1934 4 tons per acre
1934	Sweet potatoes	2,308 lbs. tubers	3,491 lbs.
1935	Early millet	28 lbs. grain	60 lbs.
	guinea corn	357 „ „	494 „
1936	Early millet	47 lbs. grain	68 lbs.
	late millet	173 „ „	191 „

Conclusion.

Although yields are low, all differences proved statistically significant. There is a definite residual manurial value remaining in the third season after application. Some other factor, other than manuring, requires attention—probably cultivation. The land is badly out of condition.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 10.

654

MANURIAL TRIAL UPON COLEUS POTATOES AT NAVRONGO IN 1934, AND THE RESIDUAL MANURIAL EFFECT UPON MIXED CEREALS IN 1935 AND 1936.

(Exp.: Nos. 10/34, 10/35, and 13/36.)

To test 4 tons of manure per acre (leached-out cattle dung from Native Administration kraal) against control, no manure.

Layout.—Strip method.

Replications.—6.

Size of Plots.—1/20th acre.

Mean yields in lbs. per acre.

Year	Crop	Control no manure	Manured 1934 4 tons per acre
1934	Coleus potatoes	500 lbs. tubers	784 lbs. tubers
1935	Early millet	21 lbs. grain	115 lbs. grain
	guinea corn	192 „ „	465 „ „
1936	Early millet	44 lbs. grain	64 lbs. grain
	late millet	133 „ „	248 „ „

Conclusion.

Although yields are low all differences proved statistically significant. See remarks, Table 9.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 11.

654 MANURIAL TRIALS UPON MIXED CEREALS AT NAVRONGO IN 1934, AND THE RESIDUAL MANURIAL EFFECTS UPON MIXED CEREALS IN 1935 AND 1936.

(Exp.: Nos. 11/34, 11/35, and 14/36.)

To test the effects of 4 tons of manure per acre and 2 tons of manure per acre (leached-out cattle dung from the Native Administration kraal at Navrongo) against control, no manure.

Layout.—Strip method.

Replications.—4.

Size of Plots.—1/20th acre.

Mean yields of grain in lbs. per acre.

Year	Cropping	Control no manure	2 tons manure 1934	4 tons manure 1934
1934	Early millet	14	71	91
	guinea corn	83	211	296
1935	Early millet	10	23	26
	late millet	189	211	336
1936	Early millet	63	93	104
	guinea corn	140	145	227

Conclusion.

The initial level of fertility was too low and the number of replications was insufficient to give us more than an indication of response to manure and residual manurial values. See note, Table 9.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 12.

MANURIAL TRIAL AT ZUARUNGU IN 1936 TO TEST "INDORE" COMPOST, AND NATIVE COMPOST AGAINST NO MANURE.

654

(Exp.: No. 10/36.)

Treatments.—3. 2 tons of "Indore" compost,
2 tons of Native compost,
no manure, control.

Layout.—Strip method.

Size of Plots.—1/40th acre.

Replications.—7.

Mean yield of grain per acre.

Crops planted	No manure	"Indore" compost 2 tons per acre	Native compost 2 tons per acre
Early millet	165	292	373
guinea corn	75	132	108

Conclusion.

All differences proved to be statistically significant. Under the conditions of the trial—typical of some of the poorest land around Zuarungu—the value of such small dressings of manure as 2 tons per acre is definite. It should be noted that whilst weight for weight native compost proved significantly better than Indore compost, a very much greater bulk of manure can be produced by the Indore process from a given head of stock than by the native method. This is important, since it is the gross yield which counts in practice.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654

APPENDIX IV—TABLE 13.

MANURIAL EXPERIMENT AT ZUARUNGU IN 1936 TO TEST THE EFFECTS OF "INDORE" COMPOST AND FARMYARD MANURE UPON MIXED CEREALS IN 1936, AND THE RESIDUAL EFFECTS UPON SWEET POTATOES IN 1937.

Treatments.—3. "Indore" compost 2 tons per acre.
Farmyard manure 2 tons per acre.
Control, no manure.

Layout.—Strip method.

Replications.—6.

Size of Plots.—1/20th acre.

Mean yield in lbs. of grain per acre.

Crop	Control No manure	"Indore" compost 2 tons per acre	Farmyard manure 2 tons per acre
Early millet	104 lbs.	207 lbs.	185 lbs.
guinea corn	92 ,,	138 ,,	150 ,,

Conclusion.

The increase in favour of manure over no manure proved to be definitely significant, but not the difference between manures. Again it must be emphasised how much lower these yields are than district means. The site of the experiment was newly acquired. Neighbouring farmers expressed surprise not at the lowness of the yields but that we got a yield at all. It is doubtful whether any residual value remains.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 14. 654

YAM VARIETY TRIALS AT NAVRONGO IN 1934, 1935, AND 1936.

(Exp.: Nos. 3/34, 3/35, and 15/36.)

To test nine Dagomba varieties of yam. Yams were planted in mounds made 5′ x 5′, a row with each variety in series. Individual mound weights were taken at harvest and the following table shows the mean weight per bearing mound for the three years of trial.

Variety	Mean weight of tubers per bearing mound		
	1934	1935	1936
Kuki	2.3 lbs.	1.55 lbs.	4.20 lbs.
Dapam	2.8 ,,	1.53 ,,	2.05 ,,
Labaco	2.3 ,,	1.04 ,,	2.75 ,,
Puno	1.9 ,,	1.70 ,,	2.97 ,,
Fugra	1.9 ,,	1.68 ,,	2.50 ,,
Zilambo	1.8 ,,	1.68 ,,	2.36 ,,
Peringa	1.6 ,,	1.14 ,,	1.81 ,,
Lili	1.4 ,,	1.07 ,,	2.24 ,,
Chenchito	1.2 ,,	—	—
Mean for all varieties ...	1.9 ,,	1.64 ,,	2.67 ,,
Bearing mounds	335	1,022	652
Percentage bearing ...	83%	67%	78%

Conclusion.

Kuki appears to be the best variety we have found up to date.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654

APPENDIX IV—TABLE 15.

YAM VARIETY TRIALS AT YEKENI IN 1934, 1935, AND 1936.

(Exp.: Nos. 4/34, 4/35, and 16/36.)

To test nine Dagomba varieties of yam. Yam were planted in mounds 5' x 5', a row with each variety. Individual mound weights were taken at harvest. The following table shows the mean yields per bearing mound obtained for each year of trial.

Variety	Mean weight of fresh tubers per bearing mound		
	1934	1935	1936
Kuki	4.3 lbs.	3.30 lbs.	2.57 lbs.
Dapam	2.6 ,,	—	2.30 ,,
Labaco	2.4 ,,	—	—
Puno	3.1 ,,	3.90 ,,	2.13 ,,
Fugra	3.2 ,,	1.15 ,,	—
Zilambo	2.9 ,,	2.80 ,,	2.11 ,,
Peringa	2.8 ,,	—	—
Lili	3.0 ,,	2.60 ,,	2.09 ,,
Chinchito	1.9 ,,	—	—
Mean weight for all varieties	2.9 ,,	3.02 ,,	2.23 ,,
No. bearing mounds ...	301	141	116
Percentage bearing ...	71%	70%	46%*

*32% of seed yams were stolen two weeks after planting.

Conclusion.

The varieties Kuki, Puno, and Dapam appear to be the best. Yields are too low to warrant extensive extension.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

APPENDIX IV—TABLE 16.

654

VARIETY YIELD TRIALS OF SWEET POTATOES AT ZUARUNGU AND NAVRONGO IN 1935 AND 1936.

(Exp.: Nos. 17/35, 19/35, 19/36, 20/36.)

To test three local varieties of sweet potatoes:—

Nanuri-sunga, entire leaves, red stem, red tuber.

Nanuri-punga, entire leaves, white tuber.

Nanuri-yadaga, indented leaves, white tuber.

Layout.—Strip method.

Replications.—6.

Size of Plots.—1/40th acre at Zuarungu.

1/20th acre at Navrongo.

Summary of mean yields in cwts. per acre.

Variety	Zuarungu		Navrongo	
	1935	1936	1935	1936
Nanuri-sunga	30 cwts.	14 cwts.	63½ cwts.	7½ cwts.
Nanuri-punga	40 „	32½ „	42½ „	24 „
Nanuri-yadaga	43 „	34½ „	40½ „	34 „

Conclusion.

Difficulty has been experienced in each year in obtaining sufficient planting material. Nanuri-sunga is the least vigorous of the three varieties and suffered most, except in 1935 at Navrongo. The reason for the comparatively high yield in that year is not understood.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654

APPENDIX IV—TABLE 17.

GROUNDNUT VARIETY TRIALS AT ZUARUNGU IN 1934, 1935, AND 1936.

(Exp.: Nos. 13/34, 20/35, and 21/36.)

To test the relative merits of an upright (bunch) type of groundnut from Nigeria against the local procumbent variety. It was considered that a bunch variety would prove more suitable for work with animal drawn implements.

Layout.—Strip method.

Replications.—11 (only 6 in 1934).

Size of Plots.—1/40th acre.

Mean yields in lbs. per acre (dry in shell.)

Year	Method of Planting	Local Procumbent	Nigerian Bunch
1934	Flat 9"×9"	784	1,043
	Flat 18"×18"	936	744
1935	Flat 2'×1'	810	998
	Ridge 2'×1'	788	835
1936	Flat 1'×9"	1,075	1,174

Conclusion.

Although the differences are not statistically significant, the balance goes in favour of the bunch variety if for no other reason than the ease of harvesting. In 1936 the labour required to harvest the Nigerian groundnut was 30% less than for the local.

7:Lynn G-5 (1932-1936) 1937 FE11 Tallensi FE11

654

APPENDIX IV.—TABLE 18.

RICE VARIETY TRIALS AT ZUARUNGU.

To test the following varieties:—

Tamale Black Selection.

Tamale Yellow ,,

Essiama NZ2 ,,

Essiama NZ4 ,,

1934. Single observation plots of ¼ acre were put down in 1934.

1935. Statistical layout was adopted.

Layout.—Strip method.

Replications.—5.

Size of Plots.—1/20th acre.

1936. Tamale Yellow, which had proved most satisfactory was tested against Local.

Layout.—Strip method.

Replications.—10.

Size of Plots.—1/40th acre.

Mean yields of paddy per acre are given below.

Variety	1934	1935	1936	Straw 1936
Tamale Black	1,463	1,605	—	—
Tamale Yellow	1,747	1,589	1,411	5,900 lbs.
Essiama NZ2	1,822	1,087	—	—
Essiama NZ4	1,742	912	—	—
Local	—	—	1,089	5,856 ,,

Conclusion.

The high return of grain and straw from rice locally and the comparative ease of cultivation with bullock drawn implements, makes rice a particularly desirable crop for the mixed farmer to grow.